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THE TELEGRAPHIC JOURNAL AND
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CABLE COMPANIES' RESERVE FUNDS.

THIS is an age of co-operation, and the principle is utilised for the promotion of objects which are to be deplored as well as of those which are commendable. The latest form of co-operation which has come under our notice can scarcely be said to be inherently bad, though from a rash administration it may possibly lead to unwise courses. The shareholders of the Anglo-American Telegraph Company—or at least a section of them—have formed themselves into an association for the protection of their interests; and this fact, as affording evidence of a determination on their part to understand the affairs of the company of which they are members, is a subject for satisfaction, for the lack of watchfulness over their doings has often led directors to adopt measures which would not generally commend themselves. There are many ways in which an intelligent interest in the business of a company displayed on the part of the shareholders may be helpful to the directors, who, generally speaking, are ever ready to give a willing ear to whatever criticisms or advice shareholders may have to offer. But it is too often the case that the remarks of the would-be critics are not intelligent; frequently they are prompted by the bitterness of disappointment, and are not based upon a knowledge of the working of the concern to which they relate. This has in no case within our experience been more frequently noticeable than at the general meetings of the various cable companies, whose shareholders have shown an extraordinary inability to comprehend that a reserve fund of apparently large proportions is absolutely necessary to the stability of the company, is a safeguard against collapse, which else might at any moment occur, and is an element which tends to give the stock of the company a high value in the market.

Excellent, therefore, as the general objects of the Shareholders' Association which has supplied us with the motive for our remarks may be, it is matter of regret that the point upon which its promoters most strongly rely as the *raison d'etre* of its existence should be that of staying the periodic increase of the reserve fund. Probably no one knows better than the directors and those who advise them, what length of time the existing cables may be expected to live, and it is their business to be prepared to replace them when they have from any cause become incapable of further use. It is possible that the Anglo-American Cables will last many years yet; but it must not be overlooked that the dangers which beset these cables are greatly in excess of those to which almost all other forms of property are subject, and it is a contingency not altogether impossible of occurrence that within a twelvemonth the directors may find themselves called upon to make a very considerable outlay either in repairs or in renewal. Then, the lives of the cables must end some day, and, notwithstanding what has been said to the contrary, it is pretty safe to say that the present reserve fund, £850,000, will not be sufficient, nor will it be nearly sufficient, to purchase and lay two fresh cables. And it must not be forgotten, too, that when the time comes to put down these new cables, if there be not more than enough for the purpose in hand, the Company has to begin again at the very beginning, and, whilst rebuilding its reserve fund, who is to guarantee it a total immunity from the necessity for further outlay? It has been said that the cables now lying in the Atlantic are more than enough for the traffic, and that even should one or both the Anglo-American Cables break, there would be no immediate need to repair them, as, in consequence of the pooling arrangements, the Company would suffer no diminution in its receipts for at least a twelvemonth. But surely the shareholders have not forgotten that last year for a space of months every cable but those owned by the Anglo-American Company was interrupted, and but for the accidental good fortune of this Company there would have been no receipts to pool. The directors best know the state of their cables, and, if anybody knows, they undoubtedly do, at what point the additions to the reserve fund may with safety be discontinued. That they believe there is no immediate danger of any large demands upon the fund may be gathered from their decision last year to appropriate to it a smaller sum by £50,000 than had for some time been their practice; and this should reassure the shareholders as to the increasing value of the property which they hold.

If the new Association studies this question with the intention of seeking the permanent interest of the company and ignoring transitory personal considerations, it will undoubtedly recognise the wisdom which has secured for the company so strong a backbone, and will abandon its present position in this particular respect. There are other directions, however, in which the energies of its committee may be usefully employed, and the gentlemen who have been so earnest and persistent in the efforts which have led to its formation may be assured of the good wishes of all holders of shares in joint stock companies if they will devote themselves to bringing about an alteration in the existing articles of association of the company, and a more discriminating surrender of proxies by the vast body of shareholders who do not attend the general meetings. If they can succeed in this they will necessarily secure what they seek, and what they are most certainly entitled to, *i.e.*, more power in regard to the spending of the money they have contributed.

USE OF WATER-POWER FOR ELECTRIC LIGHTING.

THE Falls of Montmorenci, seven miles from Quebec, have an almost perpendicular fall of 262 feet, and have for many years been utilised as a motive-power for some lumber mills near their base. Everything is now ready for the introduction of electric lights into Quebec, and the electricity will be generated by water-power from these falls. The writer (Ralph S. Tarr, in the New York *Electrical Review*) visited the works in August last in company with their owner.

The water is conducted from the river through a sluice-way to the edge of a precipice, where it is collected in a tank. This tank is tapped in two places, one opening into a tube which leads to the works below; the other through a waste sluice. The latter leads from the upper part of the tank just above the level of the tube, and as long as water runs down this sluice it is a sign that the tube is filled. The amount of water that runs into the tank can be regulated by lessening the quantity of water which supplies the power in the saw-mill, for this supply is tapped from the regular sluice nearer the falls.

The tube leading to the works has an inside measurement of 4½ feet at the top and gradually diminishes to 24 inches at the base. It is built of three-inch wood at the top and of one quarter inch boiler-plate iron for the lower three-fourths of the length. It is calculated to last for 50 years. So great is the pressure that the water actually oozes out through the lower portion of the wooden part of the tube. There is a weight of 165 feet of water at the base of the tube, where it will turn a turbine wheel at such a rate as to furnish 800 or 900 horse-power. The tremendous pressure exerted by this column of water is well shown when one turns on a hydrant which throws a stream of water with such force as to make a deafening roar as it strikes the side of a neighbouring building. There are eight of these hydrants at different parts of the lumber yard, and no building is out of reach of a heavy stream of water. On the roof of the main building an iron tube, perforated with holes, is run along the ridge-pole so that in two minutes the whole roof can be flooded.

The large conducting tube is led into the basement of the building and the water can be turned into a 24-inch iron turbine wheel with eight buckets. The pressure is sufficient to turn the wheel at the rate of 610 revolutions per minute. A perpendicular steel shaft turns two heavy cogs, which transfer the motion to a horizontal shaft making 900 revolutions per minute. On this horizontal shaft there are eight pulleys, four feet in diameter, which are connected with eight dynamos on the floor above. Enough electricity will be generated to supply 800 arc lamps in different parts of the city. The turbine is to be kept at the constant velocity of 610 revolutions per minute; this is regulated by a governor connected with a gate which increases or decreases the amount of water flowing into the turbine. To prevent the water in the tube from freezing during the day, when the dynamos are not working, the water will be allowed to run through a gate at the end of the tube, thus keeping up a constant circulation.

Everything connected with the works is constructed for durability, and is much stronger than is really needed. There are no belts, and the power is conducted to the dynamos almost directly. The ends of the horizontal shaft rest upon Babbitt metal, and to prevent heating the support of the shaft is hollow, and will be filled with a constantly flowing stream of cold water. The water for turning the turbine is carried three-quarters of a mile from the falls to the works.

The works were not in operation when the writer visited them, but the lumber mills have been lighted by electricity for some time. The power for this purpose is furnished by an 8-inch turbine (probably the smallest in the world), running with a force of 60 horse-power, and connected with a dynamo that can run 20 lights. Only nine lights are in operation, and are much more satisfactory than those at present used in Quebec.

Electrical Formulæ.—We have received from Mr. Moon a reply to Mr. Andersen's last letter, but too late to be inserted, owing to its extreme length, in our present issue.

ON THE LAW OF THE ELECTRO-MAGNET AND THE LAW OF THE DYNAMO.[*]

By SILVANUS P. THOMPSON, D.Sc., B.A.

IT is remarkable, considering the vast amount of research that has been made, that authorities in physics are in so little agreement as to what the law of the electro-magnet is. Upon the one topic that is all-essential to the electric engineer the professed physicist is either silent, or gives mathematical rules that are hopelessly wide of the observed facts, and based in most cases on no consistent theory. The expressions given by Weber[†] for the relation between the magnetising force and the induced magnetism are an exception; but they are unmanageable in the extreme, and have led to no useful results. The expression given by Lamont[‡] is also based on a certain consistent theory, but it appears to be entirely unknown both to physicists and to electric engineers, and is to be found only buried in the depths of Lamont's own treatise, The two mathematical formulæ which are most often given in treatises on physics as representing the relation between the magnetising current and the induced magnetism of the electro-magnet are the following:—

Lenz and Jacobi's Formula.—According to the experiments of these early investigators (1839), the magnetism of the electro-magnet is simply proportional to the strength of the current and to the number of turns of wire in the coil. This may be written as

$$m = k \, \mathrm{S} \, i,$$

where i is the strength of the current, S the number of turns in the coil, k a constant depending on shape and quality of iron, and m the strength of the pole. Joule (1839) showed this rule to be incorrect, and that as the iron became saturated, m ceased to be proportional to S i.

Müller's Formula.—Müller gave an expression of the form:—

$$m = b \tan.^{-1} \frac{\mathrm{S}\, i}{a},$$

where b and a are constants, depending on the form, quantity, and quality of the core and on the form and disposition of the coils. Very similar formulæ have been used by Von Waltenhofen, Dub, Cazin and Breguet. They are purely empirical, fail to represent the facts with accuracy, and have, moreover, the defect of not lending themselves conveniently to use in the equations of electro-magnetic motors, dynamo-electric machines, and other kinds of electric machinery.

More recently another formula has been coming into use, and is known—for reasons which will presently appear—as Frölich's formula: it is written

$$m = \frac{i}{a + b\, i},$$

where a and b are again constants, b being the reciprocal of the maximum value of m. This formula, like the preceding, is a perfectly empirical expression not based in itself upon any physical theory, but it accords with the observed facts of the electro-magnet better than any of the preceding formulæ. Frölich, who in 1878 was using merely Lenz and Jacobi's formula[§], appears to have adopted this expression in 1880[||], in consequence of the experiments which he had made with dynamo machines. A similar formula had been used 25 years before by Robinson[¶] to express the lifting power of an electro-magnet, and similar formulæ have been used by Oberbeck[*], Fromme[†], Clausius[‡], Ayrton and Perry[§], and Rücker[||].

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[*] Read before the Physical Society, 14th November, 1885.

[†] Weber, *Elektro-dynamische Maasbestimmungen*, p. 572. See also Maxwell, "Electricity and Magnetism" (2nd edition), vol. ii., p. 78.

[‡] Lamont, *Magnetismus*, p. 41.

[§] Frölich, *Die Lehre von der Elektricität und dem Magnetismus*, p. 237.

[||] Frölich, *Berl. Berichte*, Nov. 18th, 1880, p. 973; also *Elektrotechnische Zeitschrift*, 1881, April, p. 139.

[¶] Robinson, Trans. Roy. Irish Academy, vol, xxii., p. 1, 1855.

Now it must be obvious that since almost the whole of electric technology deals with the electro-magnet and its applications, it is of utmost importance to know what the true law of the electro-magnet is. If the technologist is left to the mercy of the physicist, he has to choose between formulæ that are based on physical conceptions and which are utterly unmanageable for his purpose, and formulæ that are purely empirical expressions and have no rational basis.

But the study of the modern dynamo-electric machine has brought us to a point that makes some decision a necessity. The entire action of the dynamo is dependent on the magnetising action of the electric current, and the law of the dynamo is, in the very nature of things, not to be discovered, save by the discovery of the law of the electro-magnet. It is indeed extraordinary that such able physicists as Mascart and Angot, Mayer and Auerbach, Schwendler, and Herwig sought in vain for the true law to connect the electromotive force of the dynamo with its speed, the resistance of its circuit, and the constants of its construction. Hopkinson came nearest to the mark when in 1879 he described the properties of the dynamo in terms of those of a certain curve, which we now call the characteristic curve of the machine; but he did not state the law of the dynamo algebraically, and apparently he accepted as true Weber's formula for the electro-magnet.

But the law of the dynamo is now known, and expressions have been deduced which are found to agree with the utmost accuracy with the observed facts. The discovery is almost entirely due to Dr. Frölich[¶], whose papers, published at intervals from 1880 to 1885, are in their way already classical. The results first obtained by Frölich related exclusively to that form of dynamo in which the armature coils and the field-magnet coils are both included in the main circuit—the series dynamo—though they have been further extended by the present writer, and by others, including Frölich himself, to other forms of machine. A very brief résumé of Frölich's research will explain his method of arriving at the law.

His theory is based upon (1) Faraday's law of induction, (2) Ohm's law, (3) a curve, called by him the current-curve, expressing certain results of experiments made on the series-wound dynamo.

Following Faraday's principle, the induced electromotive force, E, will be proportional to the speed of the machine, n, and to a quantity, M, which Frölich calls the "effective magnetism," and which is itself proportional to the effective area of the armature coils and to the intensity of the magnetic field. Writing this as an equation, we have

$$\mathrm{E} = n\,\mathrm{M},$$

and, by Ohm's law,

$$\mathrm{E} = i\,\mathrm{R},$$

which gives us for the current, i,

$$i = \frac{n}{\mathrm{R}}\,\mathrm{M},$$

or

$$\frac{i}{\mathrm{M}} = \frac{n}{\mathrm{R}}.$$

Since M is itself a function of i, and not primarily of n or R, it is clear that i is itself a function of n/R, and we may write

$$\phi\,(i) = \frac{n}{\mathrm{R}}.$$

This function Frölich set himself to investigate by pure experiment without making any hypothesis whatever. He determined the values of i at various speeds and with various resistances, and plotted out the results as a curve, values of i being taken as ordinates and values of n/R as abscissæ. This curve (see figure) he termed the "current-curve." It shows itself to be very nearly a straight line, which, however, does not pass through the origin. The portion which departs from the line is difficult of observation because it is only obtained when either n is very small or R very large, that is to say when the dynamo is scarcely able to excite its magnets. Neglecting this unstable state, and dealing only with that part of the curve which relates to the machine as it is when in action, it is clear that the relation between the two variables may be expressed as

$$b\,i = \frac{n}{\mathrm{R}} - a,$$

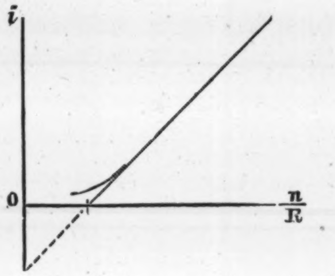
where b and a are constants; giving us as the equation of the series-dynamo:—

$$i = \frac{1}{b}\left(\frac{n}{\mathrm{R}} - a\right).$$

Substituting for n/R its equivalent i/M, Frölich then obtained from the law of the dynamo the following expression for the "effective magnetism":—

$$\mathrm{M} = \frac{i}{a + b\,i},$$

an expression which he himself appears, in his original paper, to have considered as a mere interpolation-formula. It is, however, this expression which is generally referred to as Frölich's formula for the electro-magnet.



It was in 1883 that the author of this paper, in working at the problem of the dynamo, realised the significance of this result of Frölich's. He had been using as the fundamental law

$$\mathrm{E} = 4\,n\,\mathrm{A}\,\mathrm{H}$$

to express the average value of the electromotive force developed by rotating in a uniform magnetic field of intensity H, an armature whose total effective area was A; and requiring a formula to connect H with the exciting current, he was considering the various equations of Müller, Weber, and others, when he became aware that Frölich's expression furnished what was needed; and, finding it necessary for the case of compound-wound machines to express the excitation in terms of ampère-turns rather than of ampères, he rewrote the formula in the following way:—

$$\mathrm{H} = \mathrm{G}\,\mathrm{S}\,i\,\frac{k}{1 + \sigma\,\mathrm{S}\,i},$$

where, as before, S i is the number of ampère-turns, G a geometrical coefficient, k the coefficient of magnetic permeability in the initial stage, and σ a small saturation-coefficient dependent on the quantity and form as well as on the quality of the iron of the core.

Writing similarly Z i, for the ampere-turns of a shunt winding, the expressions for H became

$$\mathrm{H} = \mathrm{G}\,\mathrm{Z}\,i\,.\,\frac{k}{1 + \sigma\,\mathrm{Z}\,i}$$

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[*] Oberbeck, *Pogg. Ann.* cxxxv., pp. 74-98, 1868.

[†] Fromme, *Pogg. Ann.* clv., p. 305, 1878.

[‡] Clausius, *Wied. Ann.* xx., p. 367, 1883.

[§] Ayrton and Perry, Journ. Soc. Tele. Eng. and Elec., xii., p. 317, 1883.

[||] Rücker, Phil. Mag. ser. 5, xix., p. 463 (June, 1885).

[¶] Frölich's chief papers are as follows:—*Berl. Berichte.* 1880, p. 978; *Elektrotechnische Zeitschrift,* vol. ii., p. 134 (1881); *ib.* vol. iii., pp. 69 and 113 (1882); *ib.* vol. iv., pp. 60, 67 and 71 (1883); *ib.* vol. vi., pp. 128, 139, 227 (1885).

for shunt-wound machines, and

$$\mathrm{H} = \mathrm{G}\,(\mathrm{S}\,i \pm \mathrm{Z}\,i_s)\,\frac{k}{1 + \sigma\,(\mathrm{S}\,i \pm \mathrm{Z}\,i_s)}$$

for compound-wound machines.

Inserting these values in the fundamental equation at once gave the following expressions :—

Series dynamo.

$$\mathrm{E} = \frac{1}{\sigma}\left\{4\,n\,\mathrm{A}\,\mathrm{G}\,k - \frac{\Sigma\,\mathrm{R}}{\mathrm{S}}\right\}$$

$$i = \frac{1}{\sigma}\left\{\frac{4\,n\,\mathrm{A}\,\mathrm{G}\,k}{\Sigma\,\mathrm{R}} - \frac{1}{\mathrm{S}}\right\}$$

Shunt Dynamo.

$$\mathrm{E} = \frac{1}{\sigma}\left\{4\,n\,\mathrm{A}\,\mathrm{G}\,k - \frac{r_a\,r_s + \mathrm{R}\,r_s + \mathrm{R}\,r_a}{\mathrm{Z}\,\mathrm{R}}\right\}$$

Compound Dynamo (at critical speed for regulation)

$$e = \frac{1}{\sigma}\left\{\frac{r_s\,(r + r_m)}{\mathrm{S}\,(r_s + r_a)} - \frac{r_s}{\mathrm{Z}}\right\}\text{(short shunt)}$$

or

$$e = \frac{1}{\sigma}\left\{\frac{r_s\,(r_a + r_m)}{\mathrm{S}\,(r_s + r_a + r_m)} - \frac{r_s}{\mathrm{Z} + \mathrm{S}}\right\}\text{(long shunt),}$$

where r_a, r_m, r_s, and R are the resistances of armature, main-circuit coil, shunt-coil, and external circuit respectively, and e the difference of potentials at the terminals of the machine. These results were announced by the author at the Montreal meeting of the British Association, and were published by him in his volume on Dynamo-Electric Machinery, as was also the important proposition that the factor $\frac{1}{\sigma}$ (which may be called *the determinant* of the working power of the dynamo, since it appears in every one of the equations, both of current and electromotive force) is that number of ampère-turns which will reduce the effective permeability of the electro-magnet, or rather of the magnetic circuit, to half its initial value. It will be seen that all these synthetical results were new, except that for the current of the series dynamo, which is identical with the expression that had been deduced by Dr. Frölich from the current curve which represented his experimental results.

Since the publication of the author's treatise, Frölich has further elaborated the equations of the compound-wound machines; and a more generalised form has been deduced by Prof. Rücker in the masterly paper which he communicated to the Physical Society in March last, in which, however, he attributes to Frölich (I know not on what grounds) the general equation for the electromotive force of all kinds of dynamos. Frölich has also verified the adequacy of these formulæ by comparing results calculated from them with actual experiments on compound-wound machines. One example will suffice.

n.	R.	e obs.	e calc.	i obs.	i calc.
850	0·841	127	127	151·0	151·0
853	1·22	133	133	109·0	109·0
855	2·34	139	140	59·9	59·4
850	4·52	138	139	30·3	30·5
850	9·25	136	138	14·7	14·7
850	22·1	137	136	6·2	6·2
845	222·0	133	134	0·6	0·6

Such a series of results proves the law of the dynamo to be fully established. But if the law of the dynamo, so deduced from Frölich's empirical expression for the electro-magnet, be true, *then*, to an equal degree of precision, *must the law of the electro-magnet be itself true.*

But Frölich's expression is not the expression of any physical law : it is a mere interpolation formula, destitute of rational significance. What then is the true law of induced magnetism? And how comes it that an expression devoid of physical significance so nearly expresses the physical law?

That question the author believes to have been already solved by a forgotten investigation of Lamont, published almost without note or comment in his *Handbuch von dem Magnetismus* in 1867. On p. 41 of that work he gives the following equation.

$$m = \frac{a\,\mathrm{M}\,x}{\mathrm{M} + a\,x},$$

as a convenient first approximation to another equation based on a new theory of induced magnetism. In the above equation x stands for the magnetising force, m the induced magnetism, and M the maximum value of the latter. Writing G k for a, S i for x, and σ for $\frac{a}{\mathrm{M}}$, we at once get

$$m = \frac{\mathrm{G}\,k\,\mathrm{S}\,i}{1 + \sigma\,\mathrm{S}\,i},$$

which is the author's way of writing Frolich's equation.

The physical theory which led Lamont up to this result is of great interest, the more so since it has been revived during the current year in a more elaborate form by Bosanquet*, who has apparently been led thereto by an independent line of thought, and who has gone much further than Lamont in bringing in the additional consideration of the forces resisting the orientation of the molecules. Lamont's theory is, briefly, that the permeability of the iron diminishes as the permeation increases, being at every stage of the magnetisation proportional to the deficit of saturation. He assumes that for every bar there is a certain maximum of magnetisation, to which it could only attain under the influence of an infinitely great magnetising force; and that the permeability of the bar is at every stage of the magnetisation proportional to the difference between the actual magnetisation and the possible magnetisation. This is, in other words, as if in every bar there were room for only a certain limited number of magnetic lines of force, and that, when any lesser number have been induced in it, the susceptibility of the bar to the reception of additional lines is proportional to the room yet left for them in the bar. Lamont's theory is expressed as follows : Let the magnetism present at any stage be called m, and let the maximum magnetism be called M. Then the amount which the bar can still take up is $\mathrm{M} - m$; and it is to this that the permeability $d\,m/d\,x$ is proportional. Here x may be understood, as itself proportional to the number of ampère-turns of the exciting current; and we may write

$$\frac{d\,m}{d\,x} = k\,(\mathrm{M} - m),$$

where k is a constant depending on the units employed, and on the initial value of the permeability of the magnetic circuit when $m = 0$. Integrating we obtain

$$\mathrm{M} - m = \mathrm{A}\,\varepsilon^{-kx},$$

where A is a constant of integration. But when $x = 0$, $m = 0$ also ; whence $\mathrm{A} = \mathrm{M}$, giving

$$m = \mathrm{M}\,(1 - \varepsilon^{-kx}),$$

which is Lamont's formula.

Lamont also develops this expression in ascending powers of $k\,x$,

$$m = \mathrm{M}\,k\,x\left(1 - \frac{k\,x}{1\,.\,2} + \frac{k^2\,x^2}{1\,.\,2\,.\,3} - \;.\;.\;.\;.\;.\right),$$

and he then makes the remark that it may be approximately represented by the simpler, but empirical expression

$$m = \frac{a\,\mathrm{M}\,x}{\mathrm{M} + a\,x},$$

which is identical in form with the expression known as Frölich's. Now, writing k for a/M,

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* Bosanquet, Phil. Mag., ser. 5, xix. p. 85 (Feb. 1885.)

$$m = \frac{M k x}{1 + k x},$$

and expanding this in ascending powers, we get

$$m = M k x (1 - k x + k^2 x^2 - \ . \ . \ . \ . \ ).$$

Neglecting the fourth and higher terms, it will be seen that the formulæ are very nearly equal for all small values of $k x$, and are identical for the value

$$k x = \frac{3}{5},$$

or when the actual magnetism has about ·456 of the value it would have under an infinite magnetising force. For larger values of the magnetising force the values of m calculated by the empirical formula are slightly greater than those calculated by the exponential formula.

None of these formulæ render any account of a phenomenon noticed in many cases where an electro-magnet is magnetised with gradually ascending magnetic forces, namely, a concavity in the *early* part of the curve of magnetisation, the permeability apparently becoming greater after a certain degree of magnetisation has been attained. The researches of Chwolson and of Siemens seem to show that this apparent increase in the permeability (which is not observed with descending magnetic forces) is due to non-homogeneity, and to the resistance of some of the molecules to magnetisation. Bosanquet's theory may be taken in connection with the recent observations of Rowland, Warburg, Ewing, and Hopkinson on this subject, which, however, is of no great importance here since the apparent maximum of permeability is attained in most cases at a much lower degree of magnetisation than that at which the dynamo is actually worked.

The very close agreement between the observed values of current and potential of the dynamo and those calculated by the equations based upon Frölich's formula, proves that nowhere within the working range do the actual values of the magnetisation differ sensibly from those calculated by the Frölich formula. That is to say, this formula may be taken as *something more than a first approximation* to the true law of the electro-magnet for all degrees of saturation of the magnets employed in practice, and may be taken as a first approximation for all degrees of saturation beyond that usually attained.

It is eminently desirable, in the face of these facts, that the imperfect formula of Lenz and Jacobi, as well as that of Müller, should henceforth disappear from the text-books of physics, and that instead thereof the true law of the electro-magnet should be stated, either in the exponential form or in the simpler form that is found to be equally true within the range of saturation attained in practice.

THE DYNAMO AS A GENERATOR AND AS A MOTOR. SOME ANALOGIES AND CONTRASTS.*

By W. M. MORDEY.

DURING the last few years an immense amount of attention has been given to everything relating to theory and practice of dynamo machines. So thorough has been the study of the problems connected with these machines, which are of a character to appeal both to the physicist and the practical constructor or engineer, that it is now not difficult to lay down, in a fairly complete form, the laws governing their action, and the rules and principles under which they should be constructed; although three or four years ago much confusion and uncertainty existed as to what was best in dynamo construction.

But in electric motors the case is very different. While it is easy to name physicists and constructors in considerable numbers who hold clear and correct views on the subject of electric generators, it is by no means easy to find definite and correct explanations of what is right and what wrong in regard to the allied subject of electric motors.

And on no point does there appear to be greater uncertainty than on that of the analogies and the differences between the two machines. For instance, while it has been proved beyond question that in dynamos the most economical and best working conditions are obtained by employing field-magnets of great magnetic strength, and armatures which are relatively very weak magnetically, the only definite assertion within the writer's knowledge given with authority on this point, asserts exactly the contrary to be the case with motors, viz., that the fields should be relatively much lighter and weaker than the armatures.*

Again, what can be more striking than the great and known difference between dynamos and motors in respect to the very important matter of efficiency! Almost any modern generator will give a return in the form of electric energy of 90 per cent. of the mechanical energy expended in it, and a useful yield of over 80 per cent. in its external circuit. In the case of the best generators this is a considerable understatement of the working conditions. With electric motors, on the other hand, one has to be contented with a much lower efficiency. The energy supplied to them is severely taxed in the process of conversion. Motors frequently yield, as mechanical energy in a useful and available form, only 30 per cent., and seldom more than 60 per cent. of the electric energy absorbed.

The reversibility of the dynamo, or its ability to work either as generator or motor, has been spoken of as one of the most important discoveries of late years (the great physicist credited with the expression of this opinion having apparently overlooked the fact that Pacinotti made his famous machine as a *motor* in the first place). But the fact that a given machine which will work well and efficiently as a dynamo, will not work so economically when its action is reversed and it is made to act as a motor, is a proof that the reversal is accompanied by some radical change in its action. This difference, where it is noticed at all, is generally sought to be explained by an assertion or a supposition that having been designed and made for one purpose, it was therefore not suitable for the other. No satisfactory explanation, as far as the writer is aware, has been given of the cause of this lower efficiency of motors, or, in other words, of how the missing power is expended. In what particulars a good motor should resemble a good dynamo, and in what they should differ from one another, are also interesting questions of great importance which await answers.

The writer having, with Mr. C. Watson—who is his assistant in the works of the Anglo-American Brush Electric Light Corporation—given some attention to the matter from a practical point of view, a great necessity was felt for some foundation on which to work, similar in character to the broad general principles which serve to guide the practical constructor of dynamo machines. In the search for such general principles, all those ways of considering the actions which depend on the idea of magnetic poles in the armature were abandoned, and the conclusion was arrived at that the armature should have no polar action whatever, that the iron of the armature should have only the function of a conductor of lines of force, and that the power of the motor should be due to the simple action between the lines of force of the magnetic field and the armature wires conveying currents at right angles to those lines of force. This mode of regarding motor action is convenient on several grounds, and leads to certain conclusions, which, if correct, form substantial bases for practical construction. Thus the armature, instead of being, as hitherto, considered as a strong electro-magnet placed in the field of another electro-magnet, is to have its electromagnetic functions reduced as much as possible, or preferably suppressed altogether.

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* From the Journal of the Physical Society.

* Profs. Ayrton and Perry, "Electro-motors and their Government," Journal Soc. Teleg. Eng. and Electricians, March, 1883.

The field is to be very strong.

As with such an arrangement there is no polar effect in the armature except that due to the direct magnetic induction of the field-magnets, it follows that the maximum power is obtained with any given current when the brushes occupy an absolutely neutral position, or, in other words, when there is no "lead" and no distortion or rotation of the field. These conditions do away with the most troublesome and prolific cause of the sparking at the brushes, which is so often an objectionable feature of most electric motors.

But by working backwards in this way it was seen at once that the conditions which seemed to be best for a motor were precisely those which the would-be designer of a perfect dynamo would set before him as his goal.

Certain perfect analogies had been arrived at. In both dynamos and motors, according to this briefly sketched view :—

(1.) The field should be a very strong, the armature a very weak electro-magnet.

(2.) In both generators and motors "lead," distortion, or displacement of brushes or of magnetic field is wrong, and is to be avoided by attention to (1).

Whatever "lead" there may be in either case, there is this difference, that in dynamos this "lead" is in the direction of rotation; in motors it is in the opposite direction, as the course of the current through the armature is reversed, but the field is the same.

(3.) In both generators and motors absence of sparking at the brushes depends mainly on the conditions of (1) being complied with.

(4.) Reversal of rotation. In neither generators nor motors is movement of the brushes necessary.

But having got so far, a little consideration suggested the probable existence of another analogy. Since a dynamo, having the above theoretically perfect form and action, with a constant field, would produce a constant electromotive force if run at a constant speed, independently of the load or amount of current generated, a motor constructed on the same principles and having a constant field, if supplied with energy at a constant difference of potential, should run at a constant speed, independently of load.

If this should prove to be a true analogy, a simple means of obtaining results of great use in the practical application of electricity would be obtained—results which have been sought in many directions, more or less complicated, without any great success.

By permission of the Anglo-American Brush Electric Light Corporation experiments were carried out in the testing room of their works, with a "Victoria" dynamo. The results ultimately obtained, which are given in the following tabulated account of the experiments, and in the curves plotted for them, show that this fifth analogy is as true as the preceding ones, a constancy of speed being obtained which was very remarkable—even when the load was increased, until much more than that which, as a generator, was usually considered the full working current was traversing the armature.

Two sets of readings were taken, working up to about the same current in each set, but with the potential-difference of the supply different in the two cases, as stated. The field was of the same strength throughout. The load consisted of another "Victoria" dynamo driven through a modified White's transmission-dynamometer, the work being varied as required by altering the external circuit of this dynamo.

At first it appeared that the counter electromotive force of the motor was dependent neither on speed nor strength of field, as the latter was constant and the former very nearly so, while the current rose with the work; but calculation showed that this was not the case, indeed, it could not be so.

Let us call the counter electromotive force e, and the loss of potential caused by the resistance of the armature e_1, and the difference of potential at the terminals E. Then

$$e + e_1 = \mathrm{E}.$$

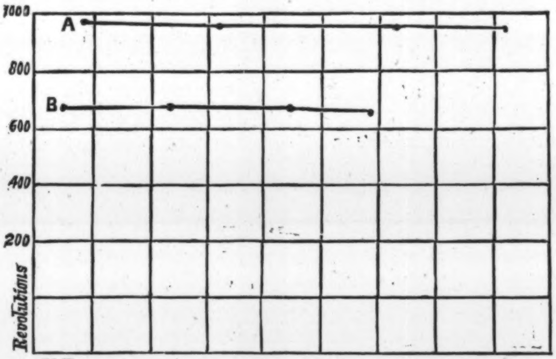
Calling the current C, and the resistance of the armature R, we know that

$$e_1 = \mathrm{C\,R};$$

The resistance of the armature of the motor in question was ·027 ohm, which we will call ·03 in order to make some allowance for the effect of heating.

Experiments with a D_2 "Victoria" Shunt Motor at Constant E.M.F.

Speed.	Current.	Difference of potential at terminals.	H.P.*	
975	36·3	140	1·8	Curve A. Maximum speed-variation 3 per cent.
965	66·5	„	6·6	
948	97·1	„	12·87	
945	130·8	„	16·3	
680	29	100	1	Curve B. Maximum speed-variation 3 per cent.
677	61·4	„	4·8	
675	102	„	9.14	
660	125	„	11·7	



Curves connecting *Speed* and *Work* of D_2 "Victoria" Shunt Motor. With supply at constant difference of potential.

In the first and last readings of the second set of tests (curve B) we have therefore the following conditions :—

Speed.	e_1.	e.
680	·87	99·13
660	3·75	96·25

Now

$$\frac{680 \times 96{\cdot}25}{660} = 92{\cdot}13.$$

From which it appears that the counter electromotive force was exactly proportional to the speed, as is to be expected where the field is constant and the magnetic distortion *nil.*

The other cases do not work out with the same accuracy. The results are, however, quite within the limits of error inseparable from the rather rough conditions of these workshop tests.

One other fact may be pointed out in connection with these tables of results and curves. In the case of dynamos working with a constant field, the output with the same current is almost exactly proportional to speed, as the E.M.F. is also simply proportional to speed So with the motor, the speed is proportional to the E.M.F. of supply; and the work, with the same current in the two cases, is simply proportional to speed, therefore to E.M.F.

With regard to the theory alluded to above, that in a motor the fields should be much weaker and lighter than the armature, it may be pointed out that in this, as in the other points mentioned, there is a real analogy between motors and generators, inasmuch as, according to the views briefly expressed in this note, such a motor, although a bad one from most points of view, would have a certain advantage in that for its weight it would do a good deal of work. Similarly, dynamos may be, and have been built, which, although far from efficient and reliable, will give a large output for their weight. Their construction is, however, scarcely to be recommended on this ground, except, perhaps, under very exceptional circumstances; and they, as well as the motors constructed on the same lines, appear to be instances of a mistaken apprehension of elementary principles.

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* Including an unascertained loss in transmission.

Having briefly traced the analogies between generators and motors thus far, the subject may be dismissed for the present with the remark that a further consideration of the matter serves only to reveal the fact that in almost every phase of their actions the two machines afford further opportunities of a direct comparison.

Turning now to the question of efficiency alluded to above, it is evident that there is some important cause of loss or waste of energy in electric motors which is absent in generators. This has always been a kind of *lacuna* in the explanations of the action of motors; and in order to localise the loss and to ascertain its cause, the several possible sources of waste were carefully considered. These are:—(*a*) Friction at the bearings, air-friction, and friction of the brushes against the commutator. (*b*) Loss of energy in heating the armature and field-conductors, and a certain loss due to self-induction. (*c*) Loss by the production of eddy currents in the iron.

Now it is evident, especially with a generator or motor having the qualities sketched above, that at the same speed, and working with the same currents in its conductors, the losses under (*a*) and (*b*) must be identical, whether it be working as a generator or as a motor. And as with such conditions its efficiency as a motor is lower than as a generator, the cause of the loss must be sought under (*c*), *i.e.*, the eddy currents in a dynamo must be less than in a motor, all other conditions being the same. And such is the case, the explanation arrived at by the writer and Mr. Watson being a very simple one.

In a dynamo the rotation of the armature causes eddy currents to be generated in the iron core, in the same direction as in the conductor proper with which the core is surrounded. Of course, as the armature is always more or less subdivided or laminated in a direction at right angles to the lines of force, any circulation of currents round the core is avoided; but local currents, which are aptly called eddies, are set up, and, taken as a whole, these eddy currents on the outside of the core are in the same direction as the current flowing in the copper conductors.

In an electric motor, however, the eddy currents and the currents in the copper conductor are in opposite directions; as, although the E.M.F. set up in the conductor is in the same direction in a motor as in a dynamo, the current in the former is forced through the armature in a direction contrary to the E.M.F., or opposite to its course in a generator. According to the laws of induction, therefore, it will be seen that while in a dynamo the two sets of currents, those in the iron and those in the conductor, tend to oppose and to reduce one another, in a motor they act in such a manner as to mutually assist each other. Thus, with the strength of field, the current in the conductor, and the speed the same in the two cases, it will be seen that in a motor the eddy currents in the iron core of the armatures will be greater than in a generator, and therefore the heat loss in the former will be more than in the latter. There is little doubt that this is the cause of the lower efficiency of motors than of generators; and it points to the advisability of giving even greater attention in the former to those principles which are well understood for the reduction or elimination of eddy currents.

THE APPLICATION OF SPRINGS TO POLARISED TELEGRAPH INSTRUMENTS.

By K. GULSTAD.

(Communicated through Mr. H. G. Erichsen.)

IT is a well known fact that the armature in a polarised telegraph instrument invariably shows a tendency to turn towards one of its two stops, or contact points, even when no current passes through the coils of the electro-magnets, and that a certain, sometimes rather considerable, force is required, in order to move the armature back.[*] When, however, this removal is effected beyond a certain limit, the inclination becomes reversed, and the armature now turns sharply towards the other contact point, to which it clings. The cause of this phenomenon may not be generally understood, although it is extremely simple and easily explained. It is principally due to the mutual attraction between the magnetism of the armature and that induced by it in the poles of the electro-magnets.[†] It must be clearly understood that any effect caused by friction, &c., is supposed to be too insignificant to be of any consequence, and that the whole polarised system here, as well as in the following, has a symmetrical plane through the axis of the armature.

In passing a weak current (just able to move the armature) through the coils of the electro-magnets, and then moving these, or their poles, closer to each other, it will be observed that this same current becomes unable to produce the desired movement of the armature after the approach of the electro-magnet poles has taken place; on the contrary, it will be found that a weaker current will suffice to bring about the result, as soon as the electro-magnets are removed from each other within reasonable limits. This experience is absolutely contrary to what might be expected from the law of the force of magnetic attraction, $f = \frac{m\,p}{d^2}$, where m, p and d respectively signify the magnetism of the armature, the magnetism produced by the current, and half the distance between the poles of the electro-magnets. According to this law the effect of the current on the armature should increase in a greatly augmented proportion as the distance between the electro-magnets became diminished. This discrepancy, as stated above, is explained by the fact that the "pressure," or "pull," of the armature at the contact points increases in a greater proportion than does the effect of the current whenever the electro-magnets are made to approach each other.

The correctness of the above explanation is proved by the calculations given below, which are based upon the above-named law and upon the expression, $f^1 = \frac{c''\,m^2}{d^4}$,[‡] *i.e.*, the law of the mutual attraction between the pole of a magnet and soft iron. c'' is a constant.

In fig. 1 E and E¹ are the poles of the electro-magnets;

a, b = the position of the armature in the distance;

x = the distance of the armature from its middle position;

a, σ and d = half the distance between the poles of the electro-magnets.

The following expression gives the formula for the *natural* attraction of the armature towards E:

$$(1) \qquad \text{A} = c''\,m^2 \left(\frac{1}{(d-x)^4} \div \frac{1}{(d+x)^4}\right),$$

which can be written:

$$\text{A} = \frac{c''\,m^2}{d^4}\left(8\,\frac{x}{d} + 40\,\frac{x^3}{d^3} + 112\,\frac{x^5}{d^5}\ \ldots\ldots\right)$$

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[*] ELECTRICAL REVIEW of 22nd August, 1885. "The Pull of the Tongue of a Telegraph Relay."

[†] In a Siemens polarised relay there is also an effect, caused by the permanent magnetism in the core of the electro-magnets. This, however, will not influence the result as stated in the following.

[‡] ELECTRICAL REVIEW of 12th December, 1885, page 507.

showing, that when x is rather small in comparison with d $\left(x \overset{=}{<} \frac{d}{3}\right)$, then :

$$\text{(2)} \qquad \text{A} = \frac{8\, c''\, m^2}{d^5}\, x.$$

The expression for the effect of the magnetism due to the current, which tends to move the armature from E towards E^1, is :

$$\text{(3)} \qquad \text{B} = \frac{m\, p}{2}\left(\frac{1}{(d-x)^2} + \frac{1}{(d+x)^2}\right)$$

$$= \frac{m\, p}{2\, d^2}\left(2 + 6\,\frac{x^2}{d^2} + 10\,\frac{x^4}{d^4} \; \ldots\ldots\right),$$

or approximately :

$$\text{(4)} \qquad \text{B} = \frac{m\, p}{d^2}.$$

It is evident that the movement of the armature can take place only when B > A, or when

$$\text{(5)} \qquad p > \frac{8\, c''\, m}{d^3}\, x.$$

It thus appears that the "pressure" at the contact points, besides being a resistance to the easy movement of the armature, also acts as a considerable hindrance to utilising the full effect of the current, as neither an increase of the magnetism of the armature, m, nor a diminution of the distance, d, of the electro-magnets will, generally speaking, prove to be of any avail. In some cases it has even been found advantageous to diminish and increase the constants, m and d, respectively, but decidedly with loss as regards the efficiency of the current.

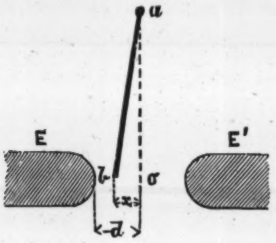

FIG. 1.

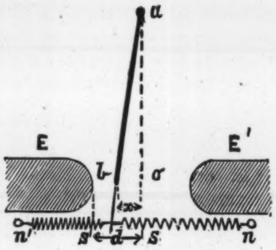

FIG. 2.

It will further be seen that, by applying the law of magnetic attraction to two magnet poles, an error is committed by having regard to the magnetic forces themselves only; this can in reality only be done where the magnetised bodies in question are saturated with magnetism, while in other cases the magnets must be considered as only partly saturated with magnetism and partly consisting of unmagnetised iron, subject to the ordinary laws of magnetic induction. This consideration should, no doubt, also be duly regarded in other cases than that treated of herein.

I may mention here that the above-named formula cannot be regarded as otherwise than approximate, owing to the equations $f = \frac{m\, p}{d^2}$ and $f^1 \frac{c''\, m^2}{d^4}$ being by no means exact. In principle, however, the results will be the same, even if d^2 or d^4 were replaced by d^n where $4 > n > 1$, as this would only cause an alteration in the power of d in the equations (2), (4) and (5).

From the above it becomes evident that great advantages would be obtained if it were possible to neutralise the effect of the mutual and natural attraction between the armature and the poles of the electro-magnets—advantages which would appear not only in an increase of sensibility of the polarised instrument in question, but more especially in an increase of its working capacity ; as already pointed out, it is only when the "pressure" at the contact points is neutralised that the constants, m and d $\left(\text{in the formula } f = \frac{m\, p}{d^2}\right)$, can be chosen so that the greatest possible efficiency of the current can be obtained.

It is this neutralisation which I have succeeded in producing, by simply attaching springs to the armature, these springs possessing such properties, and being fixed in such a manner, that, whatever the position of the armature may be, they act upon the same with forces equal, but opposite, to those arising from the above-mentioned natural attraction. The springs must have certain capacities, as shown in the following example.

In fig. 2, $b\, n$ and $b\, n^1$ represent two springs acting in the same straight line and perpendicular on the plane of symmetry through the turning axis, a ; their two ends are supposed to be fixed to movable points, n^1 and n, and they may be stretched with certain forces which, when the armature is in its central position, a, σ, between the poles, E and E^1, effect a prolongation of δ and δ^1 respectively in the lengths marked l and l^1 of these springs. The tensions of the springs follow Hooke's law ; thus $\text{K} = c\,\frac{\delta}{l}$, and $\text{K}^1 = c^1\,\frac{\delta^1}{l^1}$, where K and K^1 are the respective spring tensions, and c, c^1, two respective constants, dependent upon the material and diameter of the springs.

Suppose the armature be placed at a distance, x, from its central position, it will then be acted upon by the springs in the direction $\sigma\, n$—opposite to that of the mutual attraction—with a force :

$$\text{(6)} \quad \text{R} = c\,\frac{\delta + x}{l} \div \frac{\delta^1 - x}{l^1} = x\left(\frac{c}{l} + \frac{c^1}{l^1}\right) + c\,\frac{\delta}{l} \div c^1\frac{\delta^1}{l^1}$$

As the springs, however, are supposed to be stretched in such proportions to each other that they keep the armature in its central position (no other forces acting upon it while thus placed), K must be equal to K^1. It follows, therefore, that

$$\text{(7)} \qquad \text{R} = x\left(\frac{c}{l} + \frac{c^1}{l^1}\right),$$

i.e., R is independent of the spring tensions δ and δ^1 but dependent upon the lengths and constants.

By now arranging that the factor of x in (7) becomes equal to that of x in (2)—for instance : by altering the lengths l or l^1, or by minutely varying the distance of the electro-magnets—the desired neutralisation will consequently be perfectly attained, whatever be the position of the armature. It is by applying springs in this way that I have produced a marvellous increase of the sensibility of polarised instruments, even in cases where the play is very small.

I may mention that there are polarised instruments in existence where springs are fixed as shown in fig. 2, but in the latter the magnitude $\left(\frac{c}{l} + \frac{c^1}{l^1}\right)$ is chosen so that the spring tension is much greater than is necessary for effecting neutralisation, the consequence being that the armature assumes a permanently central position, such as is intended.

It will easily be seen that the way of fixing the neutralising springs, as shown in fig. 2, is by no means the only one which can be used with advantage. If, for instance, the turning axle itself be made from a wire of given length or diameter, the result arrived at will be the same.

Whether the adjustment for attaining the above-mentioned neutralisation by means of spring tensions is more or less perfect, may be seen from the ease with which the magnetic armature follows the movements of a small piece of soft iron. Suitable springs, once properly adjusted, need, as a rule, no re-adjustment, except when in course of time greater alterations in the constants of the springs or in the strength of the magnetism of the armature may occur ; and then re-adjustment is easily effected where the poles of the electro-magnets can be moved, without disturbing the symmetry in the polarised arrangement.

As regards the influence of earth currents upon the adjustments, I must refer to equation (4). From this it appears that the effect of a constant earth current on the armature is likewise constant (for any position of the armature), which effect, therefore, is best neutralised by a constant counteracting force. In the example in question, such a counteraction is obtained by tightening one of the springs, $n\,b$, or $n^1\,b$, as by doing so, a constant and adjustable force $\left(c\,\frac{\delta}{l} \div c^1\,\frac{\delta^1}{l^1}\right)$ is introduced (equation (6)). The same result may be obtained when either the fixed contact points or both the electro-magnets are moved bodily to either one side or the other. In the former instance (Siemens's relay), and in the latter (the new form of Wheatstone's receiver) the springs should be attached to the movable parts.

Besides neutralising the "pressure" of the contact points, the application of springs to the armature of polarised telegraph instruments has an additional advantage, viz., that of diminishing the effect of the extra currents in a purely mechanical manner. Let the effect of the current upon the armature be A, that of the extra current B, of the natural and mutual attraction ("pressure") C, and that of the spring tensions D—all these forces supposed to be acting simultaneously—then, each time the direction of the current changes, the total effect is expressed by :

$A \div B \div C$, when no neutralisation is applied ;
$A \div B$ when complete neutralisation is used ; and
$A \div B + (D \div C)$, where $D \div C > 0$, when the spring tension is greater than the natural attraction.

It might, therefore, probably be found more advantageous in high-speed working to apply somewhat more powerful springs than are otherwise strictly necessary as regards neutralisation.

With regard to the application of springs I may remark that, according to circumstances, I have been able to produce a sensibility ranging from four to ten times that of the original, and that not always with a specially delicate adjustment—a sensibility the influence of which will be easily understood by experts, and which, to a considerable extent, approaches that of Sir William Thomson's recorder.[*]

With regard to the recorder, compared with polarised telegraph instruments, I may point out here the incorrectness in attributing the superiority of the former instrument to the absence of residual magnetism ; amongst other reasons : because the principal property of the recorder is not capacity for high speed work, during which the residual magnetism specially appears, but sensibility, to which latter, leaving out of consideration the manner of working, the absence of the natural attraction between the movable part and the electro-magnets or magnets, is the only essential cause.

MAGNETISM.

By WILLOUGHBY SMITH.

(*Continued from page* 12.)

FARADAY says that a magnetised steel ring shows no external sign of power, because the lines of force of one part are continued on by every other part of the ring ; and he instanced this assumed condition with a view of strengthening *his* hypothesis. But, if such a state of things did really exist, then, in my opinion, the hypotheses I have ventured to bring forward could not be maintained ; for, as I understand it, no atom or combination of atoms in any form, animate or inanimate, liquid, solid, or gaseous, can exist in an unpolarised state or without possessing magnetic lines of force. It must, of course, be understood that the external lines of force would be much stronger from a piece of metal in the form of a bar or horseshoe than they would be if the same were made into a continuous ring, assuming each to be polarised to the same intensity. As already intimated, I assume that each atom composing our atmosphere is in a state of polarisation and is influenced by the magnetic force emanating from the earth. The magnetic lines of force given out by each polarised atom of air in turn affect, more or less, each atom of matter immersed in it ; and these atoms in a similar way throw out their own lines of force, and the intensity of these curved lines is no doubt influenced by the nature and form of the mate- from which the lines emanate. I know of no means by which the accuracy of all such views as these can be experimentally proved unless it be admitted, which I believe to be the case, that the force which is called gravity is the effect of such an universal system of polarisation with which God has endowed all matter.

Iron, especially when in a soft state, is very susceptible of polarisation from the effects of what is called terrestrial magnetism (the polarised atoms of the air) ; in fact, it is as difficult to keep it from being affected by polarisation as it would be to manipulate a sponge in a liquid without its becoming more or less saturated with it.

In my endeavour to experimentally demonstrate the existence of magnetic lines of force, I have generally employed the following very simple but efficient arrangement, which measures the intensity and shows the direction of the lines of magnetic force emanating from "magnetic metals," in a closed ring or in any other form, artificially magnetised, or "unmagnetised," as it is said to be, when it has not been directly influenced by a natural or artificial magnet. This arrangement is shown in diagram 1, in which A represents a short thin steel magnet suspended top and bottom by a single silk fibre in the centre of a small vulcanite or wooden frame. On one side of the magnet is fixed a small thin circular lensed mirror ; the magnet, mirror, and method of suspension being similar to that generally adopted in Sir William Thomson's mirror reflecting marine galvanometers, the magnet, mirror and fibre weighing in all about 2 grains ; B represents a lamp, or any convenient source of light, so placed that a beam from it will impinge on to the mirror, which reflects it on to a graduated scale, C, placed at the proper distance to receive it in the form of a well defined vertical beam about ·1 of an inch in width and 1·0 in height. The mirror, lamp, and scale should be adjusted so that, when the magnet is parallel with the lines of the earth's magnetic force, the reflected beam stands at zero on the scale. In an arrangement of this kind the resistance to its motion presented by the air, and the torsion of the fibre is so slight that the angle of deflection of the magnet is, as far as could be ascertained, directly proportional to the force affecting the same to any degree within the limits of the scale, and from such delicacy great accuracy is insured. D represents a stand, placed at the back of the magnet, on which the body under experiment is manipulated. This stand should be in no way connected to that on which the magnet is placed, in order that all disturbances from mechanical movements and other causes may be prevented from affecting the magnet. The number of interesting and instructive experiments which can be made by the aid of this simple arrange-

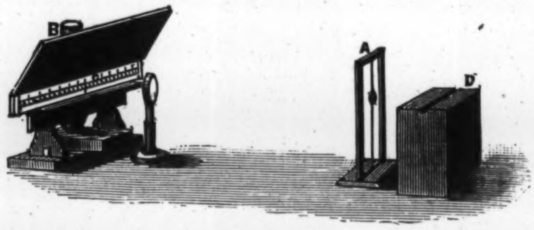

DIAGRAM 1.

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[*] I have thus succeeded in deflecting the armature of a Siemens relay through 70,000 ohms by means of one Leclanché cell, this resistance being the largest at my disposal during the time of my experiments.

ment will not be apparent at first sight, but, as the experimenter proceeds, he will find that as soon as he has settled one question to his own satisfaction, another will suggest itself.

A rod of annealed charcoal iron 10 inches in length and ·31 inches in diameter, the length being divided by marks into 20 equal parts, was placed in a groove on stand D, and at a distance of 6 inches from the magnet. The positions of both magnet and rod were north and south, consequently they were parallel to each other. The north end of the rod was first placed exactly opposite the centre of the magnet, and the deflection of the magnet noted, the rod of charcoal iron being polarised by the earth's magnetism alone, or, to speak more correctly, by the polarised molecules of air in contact with it; the rod was then slowly moved in the same straight line towards the north, and the deflection noted every time one of the marks on the bar was opposite to the centre of the magnetic needle.

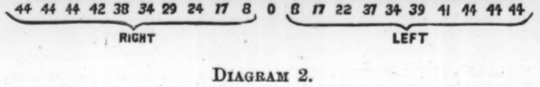

DIAGRAM 2.

The results are shown in diagram 2, where it will be seen that at or near the end pointing to the north the deflection produced is at a maximum to the left of the scale, and that, as the rod is moved, the deflection gradually decreases until the centre of the rod is at right angles to the centre of the magnet, when all influence of the rod upon the magnet apparently ceases; but, as the movement of the rod proceeds, the magnet becomes again affected, but in the opposite direction, the deflection being to the right of the scale; and it gradually increases until the south end of the rod is at right angles to the centre of the magnet, when the maximum is again reached. Other results observed with this particular specimen of iron showed that the amount of magnetism and direction of polarity induced, depended upon the position in which the rod was held. And, consequently, if the position were changed, the intensity and polarity were also changed.

If the iron rod be placed parallel with the earth's magnetic lines of force, it will become magnetised in the direction of its length, but if placed at right angles to these lines it becomes magnetised in the direction of its width; or, in other words, a magnetisable body becomes magnetised by induction from the polarised lines of the earth's magnetism, in a direction parallel to those lines. The value for any particular position remains constant, so that, whenever the rod is placed in the same position, the same value is obtained, provided the rod has not been subjected to any mechanical agitation. It therefore follows that the magnetism induced in the rod may be varied or reversed, by simply altering its position in relation to the earth's magnetic polarised lines. A few moments' thought and reasoning on the nature and results of this experiment may not be altogether without instruction.

Consider that a length of magnetised iron or steel of any form, will, if at liberty to do so, always rest in a position symmetrical to the polarised lines of magnetic force emanating from the earth or from any other source. If, however, there are two sources of magnetic polarisation acting at the same time, then the iron or steel will take up a mean position. The iron and steel emit their own polarised lines of force, which, more or less, affect each other, endeavouring so to move the masses of metal from which they proceed as to permit of the lines of force emanating therefrom being, as nearly as possible, symmetrical to each other, and then all apparent influence ceases. In the case of the small magnet, freely suspended in the neighbourhood of the polarised rod of charcoal iron in the experiment before described, the rod of iron and the small magnet both sent forth their own lines of polarisation, causing the relative position of the two bodies to be so altered as to allow the magnetic lines of force emanating therefrom being symmetrical to each other, or, at least, as nearly so as the interfering earth's magnetic field permitted them to be. In this case it is only the magnet that moves, the rod being, for all practical purposes, a fixture. It follows that what is taking place when the iron rod is moved in the vicinity of the magnet in the manner before described is, that, as the rod is moved the lines of force proceeding therefrom are also moved; consequently, the position of the lines relatively to those produced by the magnet is changed, and the latter, being free to move, is influenced by its own lines of force, which change their position until they again become symmetrical to those of the rod, and thus the deflection of the magnet is caused. It has long been known that a magnetic needle, if suspended so as to be movable only in the vertical plane, will remain in a *horizontal* position at the magnetic equator; but, if gradually moved from that position either in a north or south direction, it will assume every degree of inclination until it reaches the magnetic pole, and there it will take up a *vertical* position. This is called the magnetic dip, and, as far as I know, no satisfactory explanation has been given to account for the phenomenon, but I consider it a beautiful illustration of the correctness of the hypothesis which I have above ventured to put forth.

In diagram 3 I have endeavoured to better illustrate these lines of force and their effect on each other, as my imagination represents them. A, B and C, show the positions assumed by the magnet in relation to the influence of the lines given out by the iron rod. As I imagine it, each atom contained in the rod of iron has its own polarising effect, consequently, each atom forming the surface of the rod affects the atoms of the medium surrounding it, and, that being so, how inadequate must be the representation of those lines, which in reality must be more numerous than the most sensitive human imagination can conceive; in fact, the phrase "lines of force," is a mere figure of speech, used for the purpose of clearly indicating the direction of polarisation.

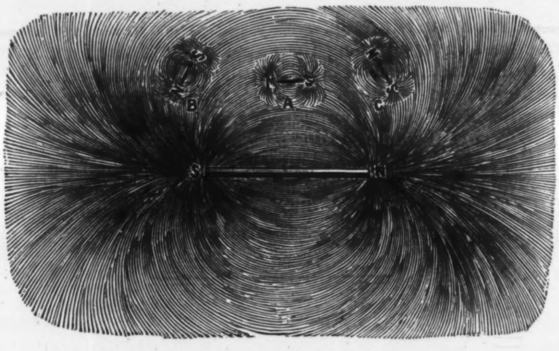

DIAGRAM 3.

Dr. Gilbert, to whom I have already referred, was the first to discover, or at any rate to publish the interesting fact, that the intensity of a magnet is altered when the iron or steel is affected by any mechanical percussion. To illustrate this, let the iron rod, as used in the last experiment, be in such a relative position to the magnet as to cause a certain deflection, it being understood that the rod is magnetised simply by reason of its position in the earth's magnetic field; and, while in that position, north and south, let one end of the rod receive a blow from any mechanical contrivance; the deflection will be then increased, and will continue to increase after each blow up to a certain point, after which no mechanical influence appears to affect its magnetism. In an actual experiment the maximum deflection was reached at the fifth blow, and the ratio between the maximum and minimum deflection was as 1 to 2·34: for instance, with the rod in a horizontal position, north and south, the deflection was 23·5, and after the fifth blow it was 55·, or 2·34 times the amount.

On another occasion when the rod was in a vertical position the deflection was 64 divisions, and after the fifth blow 150 divisions, which is, as in the previous case, 2·34 times the original amount; the ratio of increase varies, however, with each specimen of iron, and depends upon its purity and dimensions.

The magnetism is not only increased by mechanical percussion, but the increase is to a great extent permament whilst the rod remains undisturbed; but if its position be changed and it is again subjected to mechanical percussion, the previous magnetism will disappear and a fresh maximum value will be obtained, which is the maximum value of the new position. Mechanical percussion appears to affect more or less magnetism, developed in any known form; but to arrive at definite and positive conclusions, a series of long and well devised experiments must be conducted with extraordinary care and patience, as there exist such a variety of circumstances, each one of which, if neglected or overlooked, might vitiate the correctness of the results. The following experiment was made in electro-magnetism. A bar of round charcoal iron ·25 inches in diameter, and 12 inches in length, was annealed by being raised to a red heat, and then allowed to remain undisturbed until the fire had died out and the bar become cold. Over a brass tube, ·31 inches internal diameter and 10·5 inches in length, were wound 520 turns of silk-covered copper wire, the total resistance of which was ·72 ohm. This helix was joined in circuit with a battery, a resistance and a key, as shown in diagram 4; H represents the helix and brass tube; I, the iron rod; R, a resistance which could be varied as required; G, one Grove cell with an electromotive force at commencement of experiment of 1·92, volt and resistance of ·23 of an ohm; K, an arrangement for making or breaking the circuit, and M, the small mirror-reflecting magnet. The resistance, R, was at first adjusted so that the intensity of the current passing through the helix alone was only ·0019 of an ampère. The lines of force given out by the helix under these conditions, and their effect on those emanating from the magnet, M, were then noted. The circuit was then broken at K, and the iron rod inserted in the helix by placing it in the brass tube. The rod was placed at right angles to the magnetic meridian, for, in that position it was not sufficiently influenced by the earth's polarised lines of force to affect the magnet, M. The circuit was then again made, and the deflection of M was as given in column A, table I. While the current was flowing the lower end of the rod was repeatedly struck until the maximum deflection of M was obtained, which is given in column B of the same table. After each experiment the iron rod was demagnetised, and the deflection caused by the helix alone for each current deducted from the values given. The current was then increased and the experiment repeated and so on, the results being all recorded in the table. The energy of the mechanical percussion necessary to increase the value in column A, to that given in column B, increases with the intensity of the current flowing, and therefore with the intensity of the magnetism induced in the rod; and it will be seen by reference to the table, that the greatest increase due to mechanical agitation is obtained when the bar is only very feebly magnetised. If the generally accepted theory be correct, a rod of iron becomes magnetised in proportion to the intensity of the magnetic field in which it is placed, unless it be near the point of saturation, and, as the magnetic intensity is proportional to the current flowing through the helix, it follows that the rod should become magnetised in proportion to the current flowing; in other words, ten times the current should produce ten times the magnetism. The values given in column B approach closely to that law, except when the rod is near saturation, but not so the values in column A. It may be assumed, I think, that the values in column B are the more correct; and that with low magnetising power, mechanical percussion is necessary for the production of the true amount of magnetism corresponding to the inducing power.

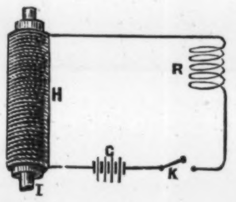

DIAGRAM 4.

TABLE I.

Current flowing through the magnetising helix. Ampères.	Deflection of the small suspended magnet.		Ratio $\frac{B}{A}$
	A Normal.	B After mechanical agitation.	
·0019	2·5	7·5	3·0
·0024	3·0	9·0	3·0
·0032	4·0	12·0	3·0
·0038	5·0	15·0	3·0
·0048	6·5	19·5	3·0
·0064	8·4	24·0	3·0
·0076	10·5	29·0	2·76
·0095	13·5	37·0	2·74
·0127	18·5	48·0	2·60
·0190	29·5	74·5	2·52
·0237	39·5	90·0	2·30
·0315	57·5	122·5	2·13
·0376	71·0	144·0	2·03
·0468	93·5	176·5	1·88
·0533	112·0	203·0	1·81
·0619	136·0	234·0	1·72
·0738	178·0	278·0	1·56
·0914	231·5	351·5	1·52
·120	331·0	465·0	1·40
·148	424·0	570·0	1·34
·174	521·0	664·0	1·27
·214	661·0	811·0	1·23
·276	865·0	1044·0	1·21
·388	1254·0	1458·0	1·16
·486	1625·0	1813·0	1·12
·651	2149·0	2349·0	1·09
·985	2850·0	2944·0	1·03
2·021	3391·0	3426·0	1·01

I have already pointed out that it is necessary to observe great caution in manipulation, to avoid arriving at false conclusions while endeavouring to ascertain the existence, and true direction, of the lines of magnetic force of a body while under the influence of the earth's polarised lines of magnetic force; and this precaution applies, even more forcibly, when making similar experiments with an iron ring or disc. A rod of best charcoal iron ·25 inch in diameter was welded into a ring 3·8 inch external diameter and made red hot; and, while in that state, was laid on a sheet of asbestos and slowly revolved in a horizontal plane until cool. This mode of cooling was necessary, for experience had taught that if the ring remained stationary while cooling, slight, but fixed polarity manifested itself at the parts of the ring facing north and south; but that if it were revolved, as mentioned, whilst cooling no fixed polarity was manifested; therefore, when the ring was placed horizontally so that the small magnet was in a direct line with the centre of the ring, no deflection of the magnet occurred; and although the ring was revolved while maintaining the same relative position to the magnet, still no deflection could be observed. It might be assumed, from this, that no lines of force were being given off by the ring, but a little thought on the subject will, I think, prove such an assumption to be incorrect. The polarised lines of the earth's magnetism affect the polarised atoms of the iron ring in their own direction, north and south, consequently the lines given out by the ring are symmetrical with those emanating from the small magnet, and, as I have already shown in the case of the iron rod, no apparent effect is developed, and it therefore follows that this condition would not be altered by revolving the ring, for, as it possesses no fixed polarity, the poles would be continually in the parts facing north and south. But if either side of the ring be brought in line with the centre of the magnet, then the positions of the polarised lines relatively to those of the magnet are altered, and, as already explained, the magnet is deflected as illustrated in diagram 5. A plate of iron, circular or of any other form, behaves in this respect precisely in the same way as the ring. The magnetic intensity in either case is increased, and definite polarity defined by a slight blow; even the flick of the finger is sufficient to produce an effect. Increase of temperature produces precisely the same results as a blow from any mechanical means. May we not therefore say that what we designate heat is the cause in each case? for it is well known that a few well-directed blows on a rod of iron will considerably increase its temperature.

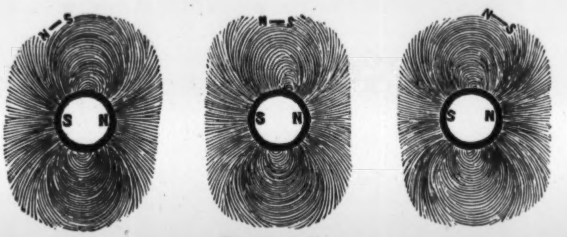

DIAGRAM 5.

(*To be continued.*)

OBITUARY.

ALFRED TRIBE.

THE late Alfred Tribe, F.R.Inst.Chem., F.C.S., whose untimely death was notified in our issue of the 5th ult., was born in London in 1839. While yet a child he exhibited a remarkable tendency for scientific investigation, especially in the fields of chemistry and electricity. His earliest professional engagements were with Dr. Forbes Watson, Dr. Medlock, and Prof. Williamson, of University College. In 1859 he became demonstrator of chemistry in St. Thomas's Hospital, which appointment he resigned in 1862, in order to prosecute his studies at Heidelberg under the celebrated Professors Bünsen and Kirchoff. Shortly after his return from Germany he undertook the management of Dr. Gladstone's research laboratory, whence, during the past twenty years, numerous scientific papers have been issued bearing their joint signatures. Among the best known of them are a series on the Copper Zinc Couple, and another on the Chemistry of the Planté and Faure accumulators. Mr. Tribe was also the author of many scientific papers which have been published in the Proc. Roy. Soc., Jour. Chem. Soc., Phil. Mag., &c., and the results of many of his famous electrical researches are embodied in Vol. II. of the late edition of Gordon's "Electricity and Magnetism," where the beautiful plates illustrating his experiments add a great attraction to the work, and in specifications of patents for his electrical storage battery. Amongst his most celebrated private researches have been those on the distribution of potential in the electrolytic field, and on the refraction of electricity; while his labours in the field of electric storage batteries have yet to be made more public to be rightly appreciated. His best known public appointments have been Lecturer on Chemistry in Dulwich College since 1874, and Lecturer on Metallurgy to the Medical School of the National Dental Hospital. His candidature for the Royal Society was supported by some of the most eminent fellows, notably, Sir W. Siemens, Profs. Spottiswoode and Tyndall; and it is more than probable that his untimely end has only just anticipated that legitimate reward of a genuine and productive devotion to the cause of science.

REVIEWS.

Dynamo-Electric Machinery. By SYLVANUS P. THOMPSON. Second Edition, Enlarged and Revised. E. and F. N. Spon, 125, Strand, London.

The publication of the second edition of "Dynamo-Electric Machinery" will be welcomed by all who are interested in electric light work. The addition of extra matter to the extent of over one hundred pages has added greatly to the value of the original work. The new information has been partly given in the form of a number of appendices, and has partly been worked into the text; thus Chapter V., on "The Reactions between the Armature and the Field Magnets" has been rewritten, introducing a section on the heating of pole pieces. Chapter XI., on "Machines for Electro-Plating and Metallurgy," is entirely new, as is also Chapter XIX. on "Coupling two or more Dynamos in One Circuit." The author points out that it is in the theory of the dynamo that the truest progress has been made. Taking the theory of Frölich as regards the electro-magnet as being the most correct for practical purposes, Prof. Thompson essayed in the first edition of his book to complete the theory of the dynamo on the foundation thus laid; a further elaboration of the expressions the author deduced has been carried out by Frölich, and a summary of these is given in Appendix IV. It is pointed out that the results agree with extraordinary accuracy with observed facts; but, as the formulæ are empirical ones, they cannot be taken in themselves as complete fundamental expressions, though the author believes he has succeeded in identifying them with formulæ originated by Prof. Lamont so long ago as 1867. A great feature in Prof. Thompson's book is the fact that it is not overloaded with a mass of formulæ which make the hair of the practical reader stand on end; the work is thoroughly practical, though theory is by no means neglected.

BOOKS RECEIVED.

Clark's Transit Tables for 1886. London: E. and F. N. Spon, 125, Strand.

The Railway Diary and Officials Directory for 1886. McCorquodale & Co., Limited, Cardington Street, Euston Square, London, N.W.

Sell's Directory of Registered Telegraphic Addresses. London: Henry Sell, 167, Fleet Street, E.C.

LAYING A NEW CABLE.

A CORRESPONDENT gives the following interesting account, in the *Sind Gazette* of December 4th, of the proceedings of the expedition to lay a new cable from Jask to Bushire, which has just completed its labours:—

The cable was coiled in the tanks of the steamships *International* and *Dacia*, 191 knots in the former and 339 in the latter. These fine vessels both belong to the India Rubber, Gutta Percha, and Telegraph Works Company, Limited, by whom the cable was manufactured. The laying was carried out under the personal supervision of Colonel Bateman Champain, R.E., the Director-in-Chief of the Indo-European Telegraph Department, assisted by Sir Henry Mance, C.Inst.E., M.I.C.E., the electrician and engineer of the Persian Gulf Section of the same department. The ss. *International* proceeded direct from England to Jask with Mr. H. Harrison, of the Indo-European Telegraph, on board in charge of testing arrangements; whilst the ss. *Dacia*, carrying Colonel Bateman Champain and Sir Henry Mance touched at Karachi on the morning of the 10th November and continued her voyage the next evening, having picked up at Karachi Mr. B T. Ffinch, Mr. Newnham, Mr. C. E. Allen, Mr. Andrews and Mr. Hopkins.

On board the *Dacia* some excitement and alarm occurred when the vessel was off Manora by the always awful cry *man overboard.* This cry cleared the dinner table at once, and an anxious crowd was soon gathered round the bulwarks. Some said that there were two men in the water, but that one had seized a life-buoy, two of which, self-lighting, were promptly thrown overboard, one by the captain and the other by the quartermaster at the wheel. A boat was lowered in a miraculously short time, and the crew giving way with a will were soon up with the poor fellow who was on the buoy. A gloom was beginning to creep over us all when it was whispered that they could not find the second man. This was, however, quickly dispelled when we heard for certain that only one man had fallen into the water, and he, after a stiff glass of brandy administered immediately from the medical comforts by Dr. Scully, was soon able to give us the benefit of his experiences. The accident was caused by the breaking of the swing bolt of one of the davits when hauling the steam launch on board. Two men were on her at the time, but one leapt on board the steamer as the launch was falling. The launch sank, and it was deemed advisable, to prevent further delay, to attach a buoy to her and proceed on our journey. On reaching Gwadur we were informed that the launch had been raised and taken into harbour by the master attendant, Captain Parker.

Nothing further of interest occurred until we anchored off Gwadur at 3.30 a.m. on the 13th November, where we took off Mr. Barker, and were informed that the remaining cable between Jask and Bushire had broken near the former station. As an example of the accuracy and smoothness with which all the arrangements for this expedition had been calculated beforehand and were carried out to the letter, we found on arriving as Jask without further mishap on the morning of the 14th, that the ss. *International* from England had anchored there the previous evening, and the ss. *Patrick Stewart* from Bushire appeared in sight soon after our arrival. By noon on the 15th the broken cable had been repaired, and the shore end of the new cable laid. At 3.25 p.m. the splice with the shore end was completed, and the *International* commenced paying out; the hitherto passengers on board the *Dacia* were told off to their different duties on board the *International*, and everything proceeded with regularity and order. Sir Henry Mance was ably assisted by Mr. Theophilus Smith, the representative of the India Rubber Company; also by Captains Tindall and Barker of the *International* and *Dacia* respectively, who with their officers and crew, and in fact everyone connected with the two ships, made by their courtesy and attention to the comforts of the officers and employés of the Indo-European Telegraph Department what might have been considered arduous duty into a pleasant trip.

The three ships left Jask in the following order:—(1) the *Patrick Stewart*, our guiding star; (2) the *International* paying out cable; (3) the *Dacia* with a fresh supply of cable, and taking soundings in our track. Soon after midnight on the 17th November the *International* finished paying out her 191 miles and buoyed the end. The staff were in the morning transferred to the *Dacia*, and by 3.25 p.m. the cable on board the *Dacia* was spliced to the buoyed end and paying out recommenced, whilst the *International*, her work being done, left us for Karachi, taking in her Mr. Newnham as a passenger for Europe. We believe she goes from Karachi to Antwerp with cargo.

With the exception of a rather heavy N.W. swell on the afternoon and evening of the 18th nothing worth noting occurred, and by 9 a.m. on the 20th about 323 miles had been paid out from the *Dacia*. The cable was now cut and buoyed, and the ship anchored off the old fort of Reshire at 9.55 a.m. Colonel Ross, the Resident at Bushire, now came on board, and after a short visit returned to Bushire accompanied by Colonel Champain, to make the necessary arrangements for landing the shore end of the cable. At 2.5 p.m. the shore end passed over the bow of the ships, and at 3.8 p.m. the first balloon buoy reached the shore. This was a most interesting sight, as a mile and a-half of cable was floated ashore on 32 buoys. About 9 p.m. the final splice between the shore end and the deep sea cable passed over the side of the ship, after which, with hearty cheers for Colonel Champain, Sir Henry Mance, and the Indo-European Telegraph Department, reciprocated with others for Mr. Theophilus Smith and the officers and employés of the India Rubber Company, the laying of the new Jask-Bushire cable came to an end, and all hands proceeded to splice the main brace.

To anyone unconnected with telegraphy the various appliances by which telegraphists can communicate with each other either by night or day by using the Morse code would appear by no means the least interesting feature of the expedition. The following methods of signalling were employed during this journey, all with great success, viz., steam whistles, flags, heliograph, lanterns, and the electric current.

We Daciaites, who had been expecting cooler weather all the way from Aden, were buoyed up with hope from Sir H. Mance's knowledge and prognostications that Karachi would be cooler, and then Jask and eventually Bushire, but only to be disappointed, as each place seemed warmer than the last, and finally on reaching Bushire we were informed that if we had only arrived the previous month we should have found it quite cool.

The ship went round to the Bushire roads on the evening of the 21st, and anchored. All who were able to obtain permission went on shore, and soon every means of locomotion in Bushire, including the Resident's carriage and most of the available *mokes* in the place were in full requisition, carrying visitors and callers from place to place. Even our scientific little skipper was noticed with two companions in a remarkable one-horse trap. The gallant captain held the rudder lines, and had, I am told, to be occasionally admonished with cries of "port, port," or "hard a starboard," when passing round corners. The Bushire Residency was as full as it could possibly hold, even to overflowing, as many of the visitors had to take shelter in tents outside. To give some idea of the extent to which the hospitality of the Residency was taxed, I noticed besides the home party consisting of Colonel and Mrs. Ross, their two daughters, and Dr. Ross, Residency Surgeon, Colonel Champain, Mr. Ffinch, Sir. H. Mance, Mr. T. Smith, Captain Bishop of the *Patrick Stewart*, Mr. Possmann, and Dr. Scully, from Shiraz. Dr. Scully and Dr. Odling changed appointments, the former acting for Dr. Odling at Shiraz, whilst the latter becomes our ship's doctor for the voyage home, where he is proceeding on leave. Everyone in and about Bushire followed the example set at the Residency, the fame of which for hospitality while under the control of Colonel Ross and his kindly wife has spread further than they could possibly imagine. Luncheons and dinners to the travellers was the order of the day; large parties of eighteen and twenty met every evening for dinner at the Residency, whilst in the afternoon almost all the Europeans in and about Bushire met on the esplanade in front of it, where Mrs. Ross presided at a tea table, whilst lawn tennis went on merrily and others promenaded. The Malek Tojar, or chief of the merchants, occasionally sent his band of Portuguese to enliven the gay scene. The musicians played well, but had rather an incongruous appearance, being dressed in uniform—red coat and black unmentionables, but allowed to wear their own soft black felt from Bombay.

On the 23rd Mr. Theophilus Smith asked a large party off to luncheon on board the *Dacia*, including all those already mentioned and Mr. and Mrs. Robertson, Mr. and Mrs. G. Sealy, Mr. and Mrs. C. Williams and many others. The party after enjoying an excellent luncheon, at which Colonel Champain made a humourous speech in honour of Mr. T. Smith and the India Rubber Company, were shown over the vessel and then returned to shore delighted with their visit. On the 23rd after a parting luncheon at the Residency during which the Captain of H.M.S. Gunboat *Philomel* joined us (that vessel having arrived in port) we again proceeded on board, several of the Bushire residents accompanying us to the vessel. Here we bade a last farewell to our hospitable hosts and proceeded on our return journey.

The weather continued warm, and as we were to call in at Jask for our mails and found we had several hours to spare so as not to arrive there in the middle of the night, Mr. Smith and the Captain were prevailed upon to anchor off Kishem at 9.50 a.m. on the 26th, and a party was soon formed to visit the salt caves on that island. After a three hours' scramble during which we visited four salt caves in some of which blue, green and red lights were fired, causing most magnificent effects and scenes like those in a pantomime, we returned to the ship laden with stalactites and crystals, having thoroughly enjoyed ourselves. Colonel Champain entered fully into the fun of the thing, and although we had several sharp showers of rain ran about as well as the youngest of the party. We anchored off Jask by daylight on the 27th, received our mails, and without anyone having gone on shore proceeded on our voyage to Karachi, which we reached safe and sound on Saturday, the 29th November, about noon.

NOTES.

House Lighting in Yorkshire.—An extensive installation of domestic electric lighting has just been completed at Oakworth, Yorkshire, the seat of Mr. Isaac Holden, M.P. It comprises about 150 incandescent lamps; a dynamo of the most improved type, capable of driving 100 incandescent lights of 20 candle-power each, and specially made either for charging secondary storage batteries or running the lights direct. The dynamo is also furnished with a flywheel to compensate for the irregular motion of the gas engine. There is a secondary battery of 110 cells in two sets of 55 in a little house in the garden, which is capable of maintaining 100 lamps for ten hours at a stretch without recharging. This, under ordinary circumstances, gives a very large margin for reserve. The power for driving the dynamo is supplied by an 8 horse-power Crossley gas engine. The dynamo chamber and engine-house is connected with Oakworth House by a large cable, which is laid to the butler's pantry, from which radiate all the minor cables for the various rooms. Here there is a perfect system of switches and safety fuses, all under the immediate control and supervision of the person in charge. The switches and fuses are the invention of Sir William Thomson, and have been specially arranged for this installation. In the large reception-rooms the splendid chandeliers formerly used for gas have been retained and adapted in the most perfect manner for carrying incandescent lamps, which are arranged in groups, screened by beautiful engraved and ground glass globes. In each room and hall there are also independent switches, so that the whole or a portion of the lamps may be put on or off at the pleasure of the occupants of the apartments. Such lamps will as a rule be served by the accumulators. The light is absolutely steady, and the effect is brilliant in the extreme. The installation has been carried out by Messrs. Muir and Mavor, of Glasgow, who have had large experience in this work, being contractors to the Government for the lighting of the Glasgow General Post Office, in which installation there are 400 incandescent lamps and 10 arc lights, most of which are running day and night.

Domestic Electric Lighting.—We have a considerable portion of our space taken up this week with matters relating to house lighting, and doubtless this will prove specially interesting to the majority of our readers.

If Sir David Salomons would now give particulars of his extensive installation at Tunbridge Wells, we are sure that still greater attention would be turned to the subject of domestic electric lighting, for it is well known that this gentleman's experience is of an almost unique character.

Water Power and Electric Lighting.—At a meeting of the Leeds Town Council, held last Friday, a Bill promoted by the Leeds Hydraulic Power Company was considered. The Bill would give an impetus to the electric lighting system. The company would be able to supply persons with power for lighting private houses and warehouses by electricity. The company wanted exclusive powers; they desired to have the monopoly themselves, and did not wish the corporation to have power to buy them up. If the Bill were carried the company would exercise the monopoly for ever, but the Bill would not be pressed if the corporation thought it would be detrimental to Leeds. It was agreed to let the subject stand over.

Sir S. P. Grant, of Rothiemurchus, on the river Spey, has introduced 80 Swan lamps into his house, and lights them by an electric current derived from a Phœnix dynamo, which is driven by a turbine. The current first charges accumulators, from which it is drawn to feed the lamps. The water is obtained from the stream by a mill-race, and on which the turbine house is situated. The stream is three-quarters of a mile from the house.

Electric Light at Middleton. — Messrs. Mather, Ormesher & Co.'s Bridge Mill, Middleton, has been for some months lighted by electricity on the incandescent system. The lights are each of 20 candle-power, and 50 of them are fixed in different parts of the works. The lights can be switched out anywhere at will, and can be all in work at once, or any less quantity down to a single light, as may be required. Messrs. Mather, Ormesher & Co. have expressed themselves perfectly satisfied with the change, and with the manner in whtch the work has been completed. The installation was erected by Mr. Thomas McClellan, of Radcliffe.

Electric Light Work in 1885. — Messrs. R. E. Crompton & Co. inform us that during the year 1885 they have completely re-organised their manufacture of dynamo machines by the substitution of the Crompton machine for the Bürgin type in all sizes and patterns. They have been fortunate enough to keep their works fully employed, and have kept a night shift going throughout the whole of the year. During the early part of the year they finished the fitting out of the Brazilian ironclad *Aquidaban*, and made six sets of search light apparatus, including engines, dynamos, projectors, &c., for the new type of sea-going torpedo boats in H.M. Navy. They also manufactured search light apparatus for H.M. ships *Black Prince*, *Shannon*, *Scout*, *Landrail*, *Curlew*, *Caroline*, *Royalist*, *Acorn*, and three others; and manufactured for the Admiralty twenty-eight sets of search light apparatus for store. Complete installations were fitted up at Sir John Fowler's house, Braemore, on the training ship *Exmouth*, for the Birmingham Liberal Club, for the Mersey Docks and Harbour Board, for the Meisenbach Company, for the Royal Institution, for the E. & W. I. Dock Company, and others. They supplied dynamos and apparatus direct for the lighting of Buckingham Palace, for Lord Bute at Cardiff Castle, for Sir David Salomons, and many others; in addition to these, through their various agents, Messrs. Bennett and Company, J. P. Fearfield, W. Hartnell, Holmes and Vaudrey, J. C. Howell, H. Lea, Muir and Mavor, and others, they supplied nearly a hundred dynamos, as well as various other apparatus, to form part of installations in different parts of the country. They have in hand, and nearly complete, a very heavy contract for the Imperial and Continental Gas Association, consisting of dynamos, steam engines, &c., for electric lighting at Vienna. They have also in hand a large contract for the E. & W. I. Dock Company for the complete lighting by electricity of the new Tilbury Docks. Messrs. Crompton & Co. have during the year brought out some notable improvements in the construction of search light apparatus by the use of the Carver mirror in place of the Mangin projector, hitherto employed in H.M. Navy. They have also designed and are executing an order for the lighting of a lightship belonging to the Mersey Docks and Harbour Board. This is a highly satisfactory summary of a year's work, and plainly shows that the electrical industry is not yet at a standstill.

Large Electric Light Installation.—Messrs. Colville and Son, Motherwell, have entrusted the Messrs. Norman, of Glasgow, to lay down a complete system of electric light, and as a consequence gas will be dispensed with immediately. The installation is to consist of 200 incandescent lights and 32 arc lamps, which are to burn for 18 hours at a stretch. The same firm have just completed the lighting of Mr. Clark's yacht, the *Mohican*, in which accumulators are largely used.

Change of Address.—The South of England Telephone Company announces that on and after the 4th January next, its address will be 50, Old Broad Street, London, E.C.

The office of the West Coast of America Telegraph Company is removed to the same address.

The Keighley Telephone Exchange.—On the 30th ultimo the Mayor of Keighley formally opened the new telephone exchange, which has just been completed in Keighley by the National Telephone Company. There were present several directors of the company, and a number of the leading gentlemen of the town. The Mayor sent the first message to the Mayor of Bradford, congratulating him upon the opening of the communication between the two towns. Several speeches were made, and messages were also exchanged with other towns in the West Riding, with which Keighley is now in telephonic communication.

The Telephone to Replace the Telegraph.—At a meeting of the Edinburgh Town Council approval was given to a recommendation of the Plans and Works Committee that telephone be substituted for telegraph communication between the head police offices in Edinburgh and Leith.

Personal.—We regret to hear that Mr. J. Aylmer, of Paris, who is well known in English electrical circles, has met with a very serious accident. On Wednesday, the 30th ultimo, whilst fixing the wires for some experiments he was about to carry out in his office the ladder slipped, and Mr. Aylmer came to the ground with such force as to dislocate his right shoulder, break his right thigh, and give himself several severe contusions. Mr. Aylmer's friends will be glad to hear that under skilful medical treatment and careful nursing he is making satisfactory progress towards recovery.

Telegraph Revenue.—The receipts on the telegraph service for the quarters of the past year were :—March 31st, £405,000 : June 30th, £445,000 ; September 30th, £490,000 ; December 31st, £410,000. The receipts for the quarters of 1884 were :—March 31st, £390,000 ; June 30th, £440,000 ; September 30th, £485,000 ; December 31st, £430,000. Thus it will be seen that, although there is an increase of revenue for the year of £5,000, there is a decrease of £20,000 in the receipts for the last quarter of the year ; this, of course, is to be accounted for by the cheapening of the rates for transmission of telegrams.

The Telegraph in the Soudan.—The resumption of hostilities in the Soudan again renders the maintenance of telegraphic communication important. On the 31st ult. the line was interrupted at Korosko, but, after communication between Cairo and the front had been broken off for only a day or so, it was restored.

Generosity among Telegraphists. — The Chicago telegraph operators very generously made up a purse for the sufferers by the Galveston fire, the funds to be presented to the ten telegraph operators at that place who were losers by the fire, several of whom have families.

Another use for the Telegraph.—In Norway it is believed that wolves are frightened away by telegraph lines. While a vote was pending on a grant to a new line, a member of the Storthing remarked that, while his constituents had no direct interest in it, they would support the grant, because the wires would drive away the wolves. It is said that, however hungry a wolf may be, he will never go into a spot that is enclosed by ropes stretched on posts. It is stated, as a remarkable fact, that since the first telegraphic line was established, twenty years ago, wolves have never appeared in its neighbourhood.

Telegraphic Addresses.—At the last meeting of the Dundee Chamber of Commerce, it was stated that the Chamber had sent a letter to the Postmaster-General in reference to the charge made for registering telegraphic addresses, which they considered too high, and an acknowledgment of the letter had been received.

Charges for Press Cablegrams.—The *Colonies and India* says that, after all, there appears to be a hitch in the arrangements for the reduction in the tariff of Anglo-Australian press cablegrams. The Eastern Telegraph Company is awaiting the official sanction of Russia, Germany, and India before making the change, which is to commence in January. This, however, can only mean a temporary delay, as those Governments were all parties to the reduction which was agreed on at the Berlin Telegraphic Congress. Mr. Murray Smith has promptly written, on behalf of the Colonies, to Dr. Stephan, the Postmaster-General of Germany, and we may be quite sure that the Eastern Telegraph Company will find no obstacles from that eminent Berlin official to the most speedy inauguration of the reduction in the tariff.

The Protection of Submarine Cables.—A telegram from the Hague says that it is expected that before the ratification of the International Convention regarding the protection of submarine cables, a special Conference will be summoned for the purpose of inquiring into the measures taken by the contracting parties to carry out the provisions of the Convention.

Electrically Propelled Vehicles.—On the 23rd ult., Herr J. Zacharias, Engineer to the Berliner Electrische Beleuchtungs Gesellschaft, gave a lecture before the "Electrotechnischen-Verein" on "Electrical Propulsion for Vehicles, Boats, &c." In the discussion which followed, Dr. Werner Siemens, Herr von Hefner Alteneck and others spoke in encouraging and complimentary terms of Mr. Reckenzaun's tramcar system now in operation in Berlin.

Dirigible Balloons.—General Thayer's system of ballooning has attracted much attention in war circles, and the *Scientific American* of the 26th ult., contains several admirable illustrations of the invention. The inventor's attention has been directed chiefly to the use of the balloon in war. He has devised two systems of dirigible balloons, in the first of which the balloon moves at any level, and entirely independent of the earth, while in the second the plane of motion is determined by means of two wires, denominated by the inventor as the balloon-way, which guide the aerial craft, and by means of an electric current effect its propulsion. In Gen. Thayer's second system, the balloon is directed by two wires or light cables stretched across the country on ordinary poles, with U-shaped iron arms on their tops. The motive power, however, is electricity, generated at the end of the line and transmitted to a dynamo machine on the deck of the balloon through wheels, which are thus impelled along the cables and move the balloon. The buoyancy of the structure supports the entire weight, and the wires of the balloon-way simply transmit the power to the motor, and enable it to be applied for propulsion. It is stated that the balloon can travel at the rate of from 60 to 70 miles an hour, under ordinary conditions of weather. It can be put up very rapidly, crossing rivers, valleys, and swamps without the necessity of intermediate supports. In fact, it appears to be a veritable telpher line.

Burglar Alarms.—Is it not a little strange that electrical burglar alarms are not more generally adopted ? The "scare" which is now at its height might easily be abated and the midnight marauders oftentimes readily caught if householders and shopkeepers would but fit up their establishments with a but rarely failing electric alarm.

Telpherage.—The telepherage system, says our trans-Atlantic namesake, is being laid before the Spencer, Mass., manufacturers with the view of laying a line between the factories and South Spencer, where the main line of the Boston and Albany railroad is met.

Electro-Motors.—The paper which we publish by Mr. Mordey on this subject will be read with more than ordinary interest, as the deductions therein are the results of the author's practical experience.

The Performance of Gas Engines.—In the letter which we publish from Mr. Greenhill, he mentions a gas engine of $\frac{1}{2}$ H.P. nominal as giving 1·2 brake horse-power. We feel interested enough to ask how his measurements were taken, for it appears to us that such a result is unprecedented with such a small motor.

Society of Arts.—We would again remind our readers of the following papers which are announced for reading before the Society of Arts at meetings previous to Easter :—At the ordinary meetings on Wednesday evenings, at 8 o'clock — "Calculating Machines," by C. V. Boys ; "Domestic Electric Lighting," by W. H. Preece, F.R.S. ; "The Experiments with Lighthouse Illuminants at the South Foreland," by E. Price Edwards. In the Applied Chemistry and Physics Section, on Thursday evenings, at 8 o'clock— "Magnetism of Ships and the Mariner's Compass," by Wm. Bottomley, jun.

Christmas Decorations.—At a children's evening party, given by Mr. Albert Kisch, of 3, Sutherland Avenue, W., a large Christmas tree was successfully lighted by means of the electric light, thus giving the whole a most striking effect, without the slightest danger of fire or destruction to the handsome presents borne by its branches. The current was supplied from accumulators placed in the corner of the room, and the work was carried out by Messrs. Woodhouse and Rawson.

Oil as a Fuel.—Last week Messrs. Cooper & Co. had their establishment in Howard Street, Glasgow, lighted for the first time by means of electricity generated by the Thomson-Houston patent dynamo machine. The noteworthy fact connected with the apparatus is that the steam for the compound Robey engine, which drives the dynamo machine, is supplied from a locomotive boiler, in which oil is used as a fuel. A tank for the oil is erected above the boiler, the oil being carried along in pipes and passed through a valve, where it unites with air drawn in by the suction of a steam jet. The steam pipe and the pipe with the oil are joined at the door of the furnace. The steam spreads the oil inside the furnace, and perfect combustion follows. To attract and distribute the oil steam requires to be raised, in the first place, by a coal fire. This, however, only occupies a few minutes, and thereafter the oil is the only fuel used. The nicety with which the heat can be regulated is also a feature. The boiler is fitted with the Fromentin feeder. It may be mentioned that this is the first installation of the Thomson-Houston plant in Scotland, and that the light is shown by the Thomson-Houston three-branch double arc lamps for running sixteen consecutive hours without renewal of carbons. The machinery has been fitted up by Mr. Richard Millar, of Glasgow.

A New Depolarising Battery Solution.—The Chemical Electric Light and Power Company, of Boston, Mass., has recently introduced a new battery solution which is claimed to possess five times the efficiency, and to perform five times the work heretofore done with bichromate of potash, besides being much cheaper than the latter. The information given in the prospectus of the company is rather vague, it being stated, for instance, that the solution has maintained incandescent lamps at full candle-power for over 200 hours, the quantity of the solution not being stated. We also have the remarkable statement that "the light produced is white, steady, safe, acknowledged by those who have seen it to be soft, bright, and beautiful, equal in all, and *superior in many ways, to dynamo incandescent lamps*." No doubt the current supplied by the battery charged with the new chemical solution is of a very high quality. The new solution rejoices in the name "Volta Pavia."

A Suggested Rival to the Telephone.—Our readers may remember that in 1884, we described the Clay Telephone system. We now learn from American sources that Mr. Henry Clay is about to introduce a gigantic system of electro-pneumatic transit, which he declares will revolutionise the present system of mail carriage and the transmission of intelligence by telephone. The scheme is one of vast proportions and elaborate detail and is founded on a new plan of transmission by pneumatic tubes controlled and governed by electrical appliances. Mr. Clay last year obtained letters patent on the invention in Europe and in his own country, and is now taking steps, in connection with George W. Bratton, towards organising a stock company to cover the United States and several companies in Europe. The system differs materially from the present pneumatic tube systems in this particular, that whereas at present several tubes are required to run from one central point to those radiating from it, by the new arrangement of electrical devices and switches the carriers are sent from the main tube leading from the central point to the various branches with a great saving of expense in tubing. One line of tube will suffice for all stations, just as do the water mains. Messrs. Clay and Bratton are confident that by this invention they will get even with the Bell Telephone Company, with whom they had such a great lawsuit last winter, since by this new system messages can be transmitted with so much greater speed, secrecy and general satisfaction.

The Daft Electric Motor.—The Daft electric motor is reported to be meeting with immense success on the street car line in Baltimore.

Blondin Outdone.—The rat, whose propensity for nibbling away the gutta-percha covering of insulated wires had already earned for it the distinction of being the *bête noir* of underground telegraphs, has determined to come out in a new *rôle*. Accordingly, one of these interesting animals held some hundreds of people in amusement in Victoria Street, Liverpool, on Saturday last, while it attempted a performance hitherto unprecedented in the annals of tight-rope walking. About half-past twelve o'clock the rat was observed on a telegraph wire running across Victoria Street, endeavouring to cross over the street on the wire. Its progress was very slow, and it was evidently in an exhausted state, from the difficulty which it experienced in clinging to the wire. It is supposed that it had escaped from one of the adjoining provision warehouses on to the roof, and then climbed up the telegraph pole, by which means it got on the wire. There is no official record of the fate of the rat.

Tenders required for Electric Lighting.—The guardians of St. Saviour's Union are prepared to receive plans, specifications, and tenders *inter alia* for lighting their infirmary by electricity. Plans, &c., should be forwarded by 13th January, to Mr. H. C. Jones, clerk, Clerk's Offices, John Street West, Blackfriars Road, S.E. Plans of the building may be seen between 10 and 4, on application to Messrs. Jarvis and Son, the board's architects, 29, Trinity Square, Borough, S.E.

Electrical Apparatus.—We shall endeavour to describe in our next issue a number of electrical switches manufactured by Messrs. Woodhouse and Rawson, for use in electric lighting installations.

The Exchange Telegraph Company and the Stock Exchange.—A petition has been presented to the Stock Exchange Committee for the readmission of the *employés* of the Exchange Telegraph Company to the "House"; and a correspondent writing to the *Times*, points out the advantages to be derived from such a course, if the Telegraph Company undertook, as it recently signified its willingness to do, to cut off "outsiders" from its system. This would be a blow to "outside brokers" and their "bucket shops" which the Stock Exchange Committee must see the advisability of dealing, in its own interest.

The Patent Office.—The President of the Board of Trade has appointed Sir Farrer Herschell, the Earl of Crawford and Balcarres, and Baron Henry de Worms, M.P., to be a Committee to inquire into the duties, organisation, and arrangements of the Patent Office under the Patents, Designs, and Trade Marks Act, 1883.

Patents.—The number of applications for patents during the year ending December 31, 1885, amounted to 16,101, being a decrease on the previous year of 1,009.

Electric Lighting Bill.—The time for depositing private Bills in Parliament has expired, and the only London Bill deposited relating to the electric light is one promoted by the West London Electric Lighting Company, which asks for an extension of time within which to carry out the powers conferred by several provisional orders, which have from time to time been granted to the company under the Electric Lighting Act of 1882. The company also seeks to exempt itself from certain provisions in that Act, which define the terms upon which electricity shall be supplied.

The Alleged Fraud by an Electrician.—Charles Stuart Cochrane, an American electrician, who was, as we have previously stated, charged at the Mansion House with personating the trustees of certain stock of the Artizans', Labourers', and General Dwellings Company, was on Wednesday committed for trial at the next sessions of the Central Criminal Court.

The Snowstorm and the Wires.—The somewhat sudden and heavy fall of snow early on Wednesday morning proved of serious inconvenience to the telephone and telegraph people. During the morning wires broke in all directions, and in some places where the wires were thickest the broken ends hung in festoons about the houses, while in different quarters, several of the wires fell into the roadway. We have not heard yet, however, of the appalling list of fatalities which we have been told to expect as soon as a snowstorm should break down the wires.

One accident, indeed, has occurred, and it was of rather a singular character. As a man named Ambrose was about to enter a tavern in Clerkenwell Road one of the lines overhead broke asunder, and the end penetrated his face, just beneath his right eye. The manager of the house nipped the wire with a pair of pliers, but failed to extract the remaining piece. Ambrose was taken to St. Bartholomew's Hospital, where his injury was successfully treated.

The Post-Office give notice of probable delay generally on all telegrams, and of considerable delay to offices in the South, South-East, South-West, and West of England, and to South Wales; also to the outlying suburbs of London.

The Submarine Telegraph Company give notice of delay to the Continent.

From various parts of the country accounts come to hand of the breakage of telegraph and telephone lines, and in many places a temporary interruption of communication has resulted.

The secretary of the United Telephone Company writes :—" Considering the heavy fall of snow that has taken place, the damage done to our wires has been comparatively slight, and, with anything like favourable weather, we shall have all communication re-established in the course of a few days."

Mr. Charles B. King, who writes to the *Times* as under, is very positive as to the dangers of overhead wires, and the ease with which they might be placed under ground :—" The severe snow storm which has visited the metropolis has once more made manifest the danger and great inconvenience of overhead telegraph wires. The condition to-day of the network of wires spanning the crowded thoroughfares is lamentable to witness, and suggests the query how the authorities could ever have permitted such an interference with public rights. An eminent judge has laid it down that anything coming by *vis major* between the line of earth and heaven is an infraction of the rights of him to whom the soil belongs. The inference in the present case is obvious, and, as the remedy is so simple, may I, in the interests of the public, draw attention, through the *Times*, to the imperative duty of the Metropolitan Board of Works and the Commissioners of Sewers of the City of London to do something more than talk and sending commissions to Continental cities to see how much we are behindhand in such matters. Speaking as an engineer, I may say it is the easiest possible thing to arrange our metropolis and city in underground sections for the disposal of telegraph and telephone wires."

We would suggest that Mr. King should submit plans for carrying out this easiest possible thing? We live and learn!

The Determination of the Ohm.—In the *Phil. Mag.* for this month Lord Rayleigh discourses upon Prof. Himstedt's determination of the ohm.

Galvanic Batteries.—In the latest number of our transatlantic namesake, Prof. Van der Weyde, the President of the New York Electrical Society, gives a chronological review of the gradual development and successive improvements of galvanic batteries. He describes the Fuller battery, which is so much employed in this country, and then goes on to say :—The Higgins battery is about the same as Fuller's, only he uses more sulphuric acid. Apparently, then, there is about as much distinction between these cells as between Cæsar and Pompey, who were said to be very much alike, especially Pompey.

Patents in 1885.—Writing to the *Times* upon this subject and commenting upon an article published in that journal, Mr. John Imray, President of the Institute of Patent Agents, says : "The suppression of abandoned provisional specifications, as well as other amendments of the law, was enacted in consequence of suggestions made to Sir F. Herschell, not by the Society of Arts, but by the Institute of Patent Agents, who, as a body, may claim some merit in having made the machinery of the new Patent Law work somewhat smoothly, a merit courteously acknowledged by the Comptroller of Patents in his official report for 1884. Many inventors will, no doubt, regret that they have been induced to trust to their own skill guided more or less by the officials in the Patent Office, in the preparation of their specifications; but how, as a result of this, 'an abundant crop of litigation hereafter' is to benefit patent agents does not appear. The patent agent, except in those cases in which he may be employed as an expert, has little to do with patent litigation; his principal business is, as far as possible, to prevent it by applying his skill and experience, his knowledge of patent law and decisions, and his general acquaintance with antecedent inventions, to keep the inventor clear of the pitfalls which open on all sides of the path that has to be trod by the patentee. Inventors have above all reason to regret that the machinery which existed in the Patent Office for the preparation of indexes and abridgments is allowed to stand still. The search for a needle in a bundle of hay is child's-play compared with that for an invention among our patent records as they now are, uncondensed, unabridged, and unindexed in any rational way."

Underground Wires.—An idea of the work before the New York Electrical Subway Commission may be gathered from the fact that 103 different plans, with models and descriptions, were submitted to the board, and on each of these a written report has been made by a mechanical engineer of the city. Out of the whole number a very small percentage, indeed, is found to possess merit enough to receive the attention of the commission, which will meet soon and from the few plans of merit will select the one which in their opinion possssses the necessary requirements for underground wire work in New York City.

Electrical Papers.—" A Note on the Electromotive Force of Certain Tin Cells," by E. F. Herroun, of King's College, London ; " Note on the Calibration of Galvanometers by a Constant Current," by T. Mather, of the City and Guilds of London Central Institution ; and some Notes by Profs. Ayrton and Perry on Dr. Lodge's paper " The Seat of Electromotive Force in the Voltaic Cell," are published in the current issue of the *Philosophical Magazine.*

Copper Resistance by False Zero Method.—The papers on this subject which were published in the ELECTRICAL REVIEW towards the end of last year, have been reproduced in our interesting little contemporary, the *Monthly Correspondent*, of Madeira.

Dynamo Machines.—In *La Lumière Electrique*, for the 2nd inst., W. Cam. Rechniewski writes learnedly on the study of dynamo machines.

Determining the Weights of Bodies.—A very interesting article by C. Decharme, on the application of electricity for determining the weights of bodies, appears in the same number of *La Lumière Electrique* as that to which we have referred as containing a study of dynamos.

A New Engine.—In our last issue we announced the registration of the Continental Etéve Engine Company, Limited. From our own experience of this motor, extending over a period of nearly two years, we do not hesitate to say that properly managed we believe the Etéve engine has a great future before it. We shall be pleased to give any of our readers what particulars they desire respecting its performance if they will favour us with a call.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES

Telegraph Improvement Company, Limited.—The annual return of this company, made up to the 28th ult., was filed on the 2nd inst. The nominal capital is £100,000 in £1 shares. 15,006 have been taken up and the full amount has been called and paid thereon. Registered office, 10, Austin Friars.

Buenos Ayres Electric Light Company, Limited.—The annual return of this company, made up to the 30th ult., was filed on the 1st inst. The nominal capital is £100,000, divided into 9,986 shares of £10 each and 70 founders' shares of £2 each. The only shares taken up are the founders' shares, and these are considered as fully paid. Registered office, 1, East India Avenue.

CITY NOTES, REPORTS, MEETINGS, &c.

The Anglo-American Telegraph Company Shareholders' Association.

SEVERAL shareholders who have been dissatisfied with the action of the directors of the Anglo-American Telegraph Company in making large annual additions to the reserve fund, have for the last twelve months been acting as a committee for the purpose of opposing the directors, and forming an association of shareholders. This committee, being self-elected, convened a meeting, which was held on Tuesday at the Cannon Street Hotel, of those who have supported them, for the purpose of securing the appointment of a permanent committee by the members. Previous to the meeting the following circular had been circulated, bearing the signature of Mr. J. Stockdale, as hon. sec. :—

> The provisional committee of this association desire to acknowledge with thanks the large amount of support received in response to their appeal to shareholders by circular on the 24th July last, which they confidently trust will be *continued*, until the just claim of shareholders, to the full division of nett earnings by this company, is enforced.
>
> In accordance with the usual custom, the proxies were presented at the office of the company more than 48 hours before the time appointed for the general meeting, but were refused, on the ground that, according to the articles of association, they should have been deposited 48 hours before the *day* of said meeting. The directors availed themselves of this quibble to evade joining issue with the committee on their resolution, viz. :—"That no further addition to the so-called renewal fund shall be made from the 1st of the present month, with the exception of the accruing interest."
>
> Nevertheless, the resolution was put to the meeting by Mr. Thomas Smith, of York, and carried by a majority of the shareholders present. The directors have, notwithstanding, refused the urgent wishes of the proprietors to discontinue any further addition to this fund, and saving the reduction of £50,000, which has been assented to, and which was absolutely necessary, in order to pay any dividend at all, they have now, for the third time, under cover of the articles of association, ignored the reasonable demands of the stockholders in public meeting assembled.
>
> Having regard to the fact that the whole of the repairs and maintenance of our four cables are defrayed out of revenue, exclusive of the appropriation (including interest) of £130,000 per annum to renewal fund, that two new deep sea cables, the 1874 and 1880, have been replaced out of our income, and that under provision of the joint purse agreement, a period of 12 months is allowed for repairs without suffering the loss of any portion of our income from the joint receipts; the sum of £850,000, which will, at least, be the amount standing to credit of the renewal fund next January, is an overwhelmingly sufficient provision for any contingency possible to be foreseen.
>
> In view of the fact that the combined cable power is more than equal to *double* the requirement of the traffic, we submit that we should not suffer ourselves to be *mulcted* any longer for the purpose of increasing this colossal renewal fund, but jealously guard against the possibility of its being squandered by any board of directors.
>
> The articles of association having been drawn up entirely in favour of the directors, without due regard to the just rights of shareholders, it is imperative these articles should be revised in the interest of the proprietors—with this object—also for the purpose of electing a committee, the present committee being provisional only, you are respectfully invited to attend a meeting of the shareholders of this company, at Cannon Street Hotel, on Tuesday, 5th January, 1886, at 3 o'clock p.m.
>
> It is proposed that the qualification for members of the committee of the Shareholders' Association, shall be the holding of a minimum of £5,000 stock; any stockholder possessing the necessary qualification, willing to serve on this committee is desired to communicate with the hon. secretary.
>
> The practice of the board of directors in sending with the half-yearly report to shareholders, a *stamped* form of proxy in their own favour, the expense of which is not defrayed by themselves, but taken from shareholders, is a course of proceeding which cannot be too strongly condemned, and for which an early remedy should be provided.

Mr. Thomas Smith, of York, who has at several recent meetings of the company moved resolutions for the discontinuance of the additions to the reserve fund, was voted to the chair. He said that the committee which had been acting for the last year was merely self-elected, and they now thought it was time for the shareholders themselves to elect from their own body a committee to represent them upon any proper occasion. As they were well aware, at the meetings of the company any single person getting up to make a proposition was merely pooh-poohed; but where there was unity there was strength, and they hoped to change all that. He might say that already, in consequence of the pressure they had brought to bear on the directors, they had conceded £50,000 from the large amount they had hitherto added to the reserve fund. That fund would at the end of the half year, if the directors carried out their proposition, amount to £850,000. The committee considered that it was absolutely necessary that the shareholders should now take some steps to prevent any further addition to that sum, with the exception of the accruing interest. There was now quite sufficient to lay two new cables, and there must occur some very unfavourable circumstances that would require two new cables to be laid within one twelvemonth. If anything should happen within a twelvemonth, it did not necessitate any loss of receipts on their part; they had twelve months, under the pooling arrangement, in which to re-lay the cable. This association was formed last February, after the meeting then held. At that meeting he (the Chairman) brought forward a motion that no further sum be added to the renewal fund. If the idea he suggested had been carried out they would have had a renewal fund of £750,000, and the company would have been enabled to pay something like 3½ or 4 per cent. But Viscount Monck did not consider it a proper thing to do, and carried out his idea of adding £150,000. He had, however, since modified his views, and only added £100,000. After that meeting in February, Mr. Stockdale, Mr. Jackson, and Mr. Brown called on him and invited him to assist them in forming an association. To this he consented, the association was formed, and they had addressed themselves to the shareholders three times. This was no small thing to do, as there were between 5,000 and 6,000 shareholders. They had received some very agreeable responses and encouraging remarks from a great many shareholders. They were now come to the period when they thought they should ask the shareholders to help them, and to form a committee from the body of the shareholders, any gentleman holding £5,000 of stock to be eligible to act. The expenses which the committee had incurred amounted to £34 18s. 8d., and they had received from the shareholders subscriptions of 5s. each to the amount of £20 12s. 6d., so that there was a balance of £14 6s. 2d. due to the treasurer, Mr. Stockdale. They had thought that it would be necessary, in order to provide for the expenses that would have to be incurred, to have a *pro rata* contribution of 1s. per cent. on the holding of the members of the association, with the reserve that the minimum should be 5s. and the maximum £5. He would propose that a committee be formed to replace the present one, which was only provisional.

Mr. Jackson seconded the proposition, and said the committee represented getting on for a million of stock, with their own stock and the proxies entrusted to them. The result of their efforts was evident in a dividend, a very small one, it was true, but one which would have disappeared altogether if the directors had not been called to account. The articles of association, he had been told, were so drawn as to leave everything in the hands of the directors and exclude the shareholders altogether. The Anglo-American Company originated with a small number of capitalists, who subscribed £600,000 to a desperate undertaking. The 1858 cable had been abandoned, and the 1865 cable had broken after only one message had been sent by it. It was thought very desirable that there should be a cable connecting this country with America, and a small meeting of capitalists was held and the money was subscribed in something like two hours. In the articles of association which were drawn up they took every care of themselves. But those articles still stood as the articles of the present company, which was not a company of capitalists; their board, indeed, represented a very small amount of capital and the shareholders had grown from a few gentlemen to 5,500 members; and yet those articles gave the directors an autocracy and almost an irresponsible power. It was only necessary for the shareholders to place it before the board that they were determined that that state of things should not continue; and if they (the shareholders) did not look after their affairs they deserved to lose their dividends. The original founders of the company received 25 per cent. per annum for the loan of their money, for they would not become the cable company, and 100 per cent. redemption money if they handed their undertaking to the company intact. That redemption money they received, and he thought they got not a bad return for their loan—£1,200,000 for £100,000 in twelve months. He told them this to show them that there was a necessity for the shareholders to wake up to their position, and to tell the directors that they have made the company so safe that whatever might arise, putting competition aside, there would be no requirement for anything like the amount they possessed. That the directors did not always think there was need for such large additions to the reserve fund was evident from the fact that in 1872, when there was a great prospect of both cables being lost, they did not put more than £60,000 to reserve. Mr. Cyrus Field had told them—and probably no gentleman living was a better judge of the value of their property or of its quality—that as possessing the shortest route to Newfoundland, their position was really a very good one. They would remember, too, that last year, when all the newer cables were broken, the Anglo-American cables carried the whole of the traffic for months. That must be evidence to them, as it was to him, that they did not require any more renewal fund. What they wanted of the directors was simply this—to stop this drain on their resources and give them their just rights; add the interest to the fund, if they would, but give the shareholders the net earnings. He took that opportunity of thanking Mr. Stockdale, who had taken a great amount of pains and spent a great deal of time upon the affairs of the association.

Mr. Prust could not quite fall in with the views of the previous speakers about the reserve fund. He had sustained a very serious loss in the company, and, viewing the subject on all sides, considering that they had now £850,000, he thought they ought to make it the round sum of £1,000,000. This would give them a solidity of which nothing could deprive them. They knew that all bank shares stood at an enormously high premium, simply because they had a large backbone. This money which formed the reserve fund came almost entirely out of the hands of the deferred shareholders; the preferred had suffered nothing. He was not quite sure that the company would not be dissolved, or be continued in another form, and he had taken the opinion of an eminent counsel upon the question as to who would be entitled to the money in case of a dissolution, and had been assured that it would belong to those who had subscribed it; supposing an American company purchased the undertaking, or it was liquidated, the reserve must be returned to those who contributed it. He thought they could not have very much longer to wait, and he thought the best policy was to let the reserve fund go on. They would recollect that at the last meeting he got a resolution passed and a promise from the directors that they would not use any of that money without consulting the shareholders. There were eight cables in the pool, but only four were being used. This was due to the contraction of commerce between this country and America, but it was evident that there was no necessity for another cable, so that they need not alarm themselves upon that head. He thought their property stood in the market at a most ridiculous price. Speaking of the articles of association, he thought there was great need for an alteration of them, and, with regard to the proxies, he hoped one of the lately returned Members of Parliament would soon bring in a Bill to suppress that iniquitous system.

Mr. Newton said he had fought many years against the board upon some of the questions with which the association proposed to deal, but he had given up his efforts many years ago. It would be necessary for them in the first place to turn their attention to procure an alteration in the articles of association. He would advise them, in order to carry an adverse vote at the meeting, to move an amendment to the report, passing it entirely with the exception of obnoxious paragraphs and the items spent in proxies. The resolution must be carefully worded, so that the chairman could not refuse to take it on the ground either that it was a direct negative or that it was out of order. He had again and again pointed out to the directors that the manner in which they used the proxies entrusted to them was a scandalous procedure. As regards the dividend, it was a delicate matter, because the interests were of so conflicting a character. Mr. Prust admitted that the only interest he took in the reserve fund was in the liquidation of the company. His (Mr. Newton's) interest, as a preferred shareholder, was not in the same direction; but he desired to say nothing from a personal point of view. With respect to the board, he did not wish to say a single word against their qualifications, but he would say they were vastly overpaid. Those of them who were in business knew that their profits had been reduced by 50 or 80 per cent., yet their earnings as directors of public companies had suffered no diminution, whilst those for whom they worked had suffered very considerably. There ought to be some connection between the prosperity of the shareholders or their adversity, and the prosperity or adversity of the directors. He did not mind paying directors very well indeed when they were paying good dividends.

Mr. Davison said that from the remarks of the speakers who had preceded, and from his own careful observation, he gathered that there were really two questions demanding their serious consideration: one the articles of association, which, apparently, although they may have answered the purpose of the company originally, were quite inadequate to the requirements of the shareholders at the present time; the second was, the magnitude of the reserve fund. With regard to the former, one of the speakers had mentioned that they might be altered by a resolution very carefully worded. From his experience, he was afraid they could not rely upon that being carried out; but if they came to the conclusion that the articles of association ought to be altered, the proper way to proceed would be to hold an extraordinary general meeting of the company for the special purpose, and, as it would probably be rather difficult to carry out the alterations at the time, a committee might be delegated to go into the question carefully. There could not be a shadow of a doubt that the reserve fund was really larger than was required. He had long ago come to the conclusion that 10 per cent., or £700,000, would be a very proper sum for this company to lay aside for such contingencies as called upon the reserve fund. Were the fund less than that he should be one of the strongest to advocate building it up; but he thought they ought to take steps to prevent its getting any larger; and it was apparent that the great body of the shareholders were anxious to stop any increase to the reserve, so that the deferred shareholders might have something like justice meted out to them.

The Chairman said Mr. Prust made a slight mistake in saying that the reserve fund was under the protection of the shareholders. The directors did not submit to the resolution that it should not be used without the consent of the shareholders.

Mr. Prust: But my resolution was carried.

Mr. Jackson: You were defeated on the poll.

Mr. Prust: I was under a misapprehension, then.

Mr. Davison thought they should be cautious in recording a resolution condemnatory of proxies; they should not take too warm a view of that subject for the simple reason that proxies really represented absent shareholders, and as a general rule the body of men present at a meeting might be supposed to be only one-tenth of the entire body, and it was rather an error to say that the other nine-tenths should not record their opinion by sending proxies. Still, he was aware that proxies were improperly used occasionally.

Mr. Griffith said when they considered that the cables in existence were more than sufficient to do double the amount of business, they must think that the time had come when their large insurance fund need not be increased. There were other cables beside their own, and those cables were able to carry on the business even if the cables of this company were broken. It might or might not be wise to allow the directors to issue proxies; but if they did so they ought to pay for them themselves. The articles of association had been very unfairly drawn, giving undue power to the managing partners. When they were first drawn there was one merit about them, for there was a stipulation that the reserve fund should be used not entirely for insurance but partly for the equalisation of dividends and other purposes. But, recognising that that gave some power to the shareholders, the directors called a meeting, and that was altered. They therefore had something to return to; their doctrines were not entirely of the socialistic order, for they wanted those rights which they had once possessed, and which they would possess again if they only had courage to persevere.

Resolutions were then submitted appointing Messrs. Davison and Griffith members of the committee; and the four gentlemen who had been acting as a provisional committee, Messrs. Smith, Brown, Jackson and Stockdale, were also appointed. No other business was brought forward, and the proceedings terminated in a vote of thanks to the chairman.

Western and Brazilian Telegraph Company, Limited.—It has been decided by the directors to recommend a dividend of 2¾ per cent. for the year ended September 30th last, placing £10,000 to the reserve fund.

Volta Electrical Company, Limited.—The creditors of this company are required to send in the particulars of their claims to the voluntary liquidators by the 11th inst., and those of the London and Globe Telephone and Maintenance Company, Limited, by the 14th inst.

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The number of messages passing over the lines of this company during the month of December was 3,023, estimated to produce £2,450, against 3,001 messages, producing £2,553 in the corresponding month of last year. The receipts for the month of September, estimated at £2,100, realised £2,160.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending January 1st were £2,150, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Great Northern Telegraph Company, Limited. The receipts for December, 1885, were £20,280; from 1st January to 31st December, 1885, £284,720; for the corresponding months of 1884, £276,280; and of 1883, £254,480.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of December were £1,754, against £1,748 in the corresponding period of last year.

NEW PATENTS—1885.

15701. "Insulation of electric and line wires." A. E. GILBERT. Dated December 21. (*Complete.*)

16009. "Measuring electric currents of the continuous, interrupted or intermittent kind." R. D. SMILLIE. Dated December 30.

16031. "Voltaic batteries." D. T. PIOT, H. CHARLES, A. LEVY. Dated December 30.

16038. "Distributing electric currents." C. D. ABEL. (Communicated by Siemens and Halske.) Dated December 30.

16088. "Carpet sewing machines." A. ANDERSON. (Communicated by Singer Manufacturing Company.) Dated December 31.

16099. "Mechanical telephone." L. N. LOEB. (Communicated by C. Loeb.) Dated December 31.

1886.

25. "Cable for the production of induced currents." H. J. HADDAN. (Communicated by A. Arndt.) Dated January 1.

40. "Mechanical telephone." W. MCPHERSON. Dated January 1.

42. "Volta-inductors." C. D. ABEL. (Communicated by Siemens and Halske.) Dated January 1.

56. "Electric governor applicable for purposes of regulation generally." G. E. DORMAN. Dated January 2.

68. "Holders for supporting incandescent electric lamps and their shades." A. SWAN. Dated January 2.

154. "Dynamo-electric machines." H. J. ALLISON. (Communicated by E. Thomson.) Dated January 5. (*Complete.*)

200. "Mechanical telephones." P. EWENS. Dated January 5.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1884.

12300. "An electric locomotive." J. C. MEWBURN. (Communicated from abroad by Marcel Deprez and M. Leblanc, of Paris.) Dated September 11. 6d. The locomotive is composed of a dynamo-electric machine of special construction. It actuates by the intermediation of cranks and connecting rods, two or more pairs of wheels coupled together in the usual manner (see fig. 1). In this way the driving wheels and the induced body of the dynamo-electric machine rotate with the same angular velocity. Two pairs of the wheels (those at the left hand of fig. 1) are of special construction. Their tyres can be magnetised, and thus provide increased adhesion when necessary, especially when starting or when ascending inclines. As these pairs of wheels should be placed near together in order to provide for a uniform distribution of the weight of the apparatus on the wheels which support it, it is necessary that the different parts of the locomotive, especially the springs, should be arranged accordingly (see fig. 1). The dynamo-electric machine is arranged in such manner as to develop as great a power as possible for a given weight which is necessary for obtaining a good tractive force. The ring, A, A (fig. 2), covered with wire is carried by a wooden support, *b*, *b*, which is itself supported by an internal wheel, or two circular cheeks of non-magnetic material. This wheel, or these cheeks, are keyed on a shaft, G, G, to which the collector, C, is also fixed. The inductor of this machine is formed of two open discs of iron, D, D (figs. 1 and 2); their width is equal to the thickness of the covered ring; they carry at intervals projecting pieces, J, J, J; J^1, J^1, J^1; which embrace the ring (see figs. 1 and 2); these pieces are of flat form, and their mean plane passes through the shaft, G, G. They are at equal distances from each other and of even number.

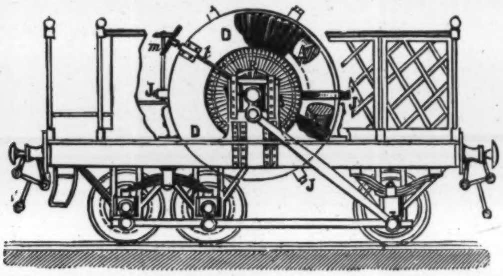

FIG. 1.

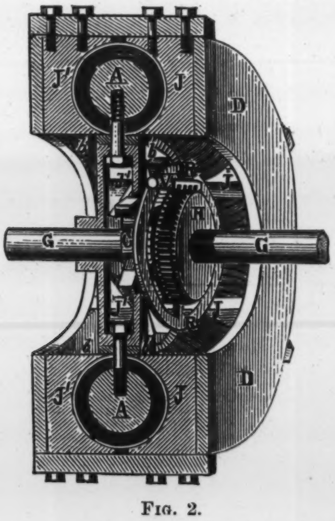

FIG. 2.

1885.

1281. "Improvements in the construction of electro-motors." D. T. PIOT. Dated January 29. 8d. The object of the invention is to increase the power of electro-motors, and this the inventor effects by enlarging the polar surfaces of the field magnets and the armature, and by so connecting the bobbins of the armature and the field magnets with the battery that the exciting current may act equally upon each with the best effect.

1288. "Improved means for establishing electric connection between surfaces in relative motion, applicable to the collectors of dynamo machines." G. FORBES. Dated January 29. 6d. According to the present invention the inventor is able to take off the current from the circumference of a disc by means of plumbago or hard carbon applied with moderate pressure to the disc.

1444. "Improvements in cable telegraphing at great distances and in apparatus therefor." P. JENSEN. (Communicated from abroad by E. Baron von Taund-Szyll, of Graz.) Dated February 2. 8d. The receiver consists of a tightly closed box containing in an interior compartment a powerful source of light, the rays from which can pass out through two small narrow slits. The releaser consists of a small spool frame similar to Sir William Thomson's syphon recorder, which is suspended in a silk fibre, and is movable within a very powerful magnetic field. The small frame has a lower prolongation or shutter, which is of triangular section, and which hangs so in front of the partition of the box as to cover exactly the slits and thus also, when the frame is at rest, prevents the light rays from the lamp from passing out through the slits. But when the cable current passes through the wires into the coils of the spool of the frame, then the frame will be swung lightly to the left or right, all according to the polarity of the current, and thus be brought nearer to one of the magnet poles. As the lower prolongation or shutter partakes of this motion, it will open for the slit and let the light rays out of the box. The rays of light act on selenium cells which are in connection with batteries and relays and a recording apparatus. (See REVIEW for December 12th, 1885.)

CORRESPONDENCE.

Telephone Patents.

It occurs to me that the public generally would be greatly benefitted and enlightened by the publication of the patents held by the United Telephone Company upon which they base their claims to a monopoly in telephones. There are certainly thousands who take a professional interest in the matter, and tens of thousands who are interested in a different way. It is of course an easy thing, if one can spare the time, to go to the Patent Office and look through all the telephone patents that have been filed, but the time required is more than most of us can spare, while, unless we can also examine all the disclaimers that have been filed from time to time, our labour would be almost useless.

The ELECTRICAL REVIEW has done much valuable work in publishing and discriminating between *bonâ fide* claims and patents and bogus ones, and if it would undertake the publication of what I have suggested, electricians and capitalists will be benefitted to a degree that it is difficult to estimate. It is a matter of certainty that there are some forms of telephones, such as the "English mechanic" and the "Glasgow" which the public are free to use, but the peculiar points of these instruments are not generally understood, and an explanation of them would be much appreciated.

I am fully aware of the great labour and expense entailed by a complete and thorough investigation and publication, but it has now become a necessity that it should be undertaken, and its importance is such as to lead to a confident hope that the ELECTRICAL REVIEW will not shrink from the task. It could not be in better hands.

H. C.

December 31st, 1885.

[During the past four years the matter of telephone patents has been very thoroughly discussed in the pages of the REVIEW. If we undertook to do that which our correspondent suggests, the result would be simply a reproduction of old matter, and we are not quite convinced that our readers would take kindly to such a re-hash, although placed before them as a single dish.

The instruments which "H. C." mentions as being free to the public are known to the most minute details to our regular subscribers, but unfortunately these apparatus cannot be practically employed interchangeably as transmitters and receivers. The transmitter is the rock on which all those who have tried conclusions with the United Telephone Company have split. However, we shall be pleased to learn the views of other of our readers who may be interested in the progress of the telephonic industry.—EDS. ELEC. REV.]

Secondary Generators or Transformers.

In your issue of the 12th inst. we find a "would-be" reply to our letter, which you kindly published in your issue of the 28th ult.; but that "reply" of Messrs. Gaulard and Gibbs can by no means be regarded as such, for the said gentlemen pursue a rather singular proceeding in the whole course of the controversy they have judged convenient to provoke.

They begin by trying to defend the pretended better qualities of their secondary generators; later on their complaints turn principally against our "usurpation" of their patent rights, and now, being convinced of the absolute groundlessness and untenableness of both pretensions, they draw forth quite new things which do not in the least interest the readers of a technical journal, and in all their letters they ride on their usual hobby-horse, viz., the report of the International Jury of the Turin Exhibition.

With regard to this last question, we have already made our remarks in a foregoing letter, and we would only add that it proves hardly in favour of Messrs. Gaulard and Gibbs, if two of those gentlemen who have co-operated in a most prominent manner with regard to the report alluded to, finish by giving preference to our transformers, the one of them, Prof. Ferraris, by proving in a later report the superiority of our apparatus, the other, Prof. Colombo, by employing them for an electric light installation to be carried out by his company.

Messrs. Gaulard and Gibbs, in order to refute our assertions, refer in their last letter to a specification of Dr. John and Dr. Edward Hopkinson, of the 24th October 1884. We cannot understand what the reference to that specification should prove against us; we think this could only prove that Dr. Edward Hopkinson, on his visit to the Turin Exhibition, has equally learned from Mr. Gaulard how a transformer should *not* be constructed. As regards ourselves, we could learn nothing whatever by the specification alluded to, as provisional specifications are held secret in England —of which fact Messrs. Gaulard and Gibbs should be aware—and the complete specification of the invention in question being dated July 27th, 1885.

As to the remark of Messrs. Gaulard and Gibbs, that there remains nothing to Mr. Zipernowski but the experience "how to construct alternate current machines, which he learnt in the good school of Messrs. Siemens and Halske," we decline entering into this matter, as this is quite out of the way of the controversy raised by Messrs. Gaulard and Gibbs, and because we are not willing to enter into disputes about new matters, as we see that the said gentlemen, in ignorance of the matter, always leave the matter.

Messrs. Gaulard and Gibbs finish by referring to an interview they had had with Mr. Blathy at the Turin Exhibition, and they add to this the "surprising" revelation that they have a letter from Mr. Blathy which will be produced by them at the proper moment. We don't know what the interviews with Mr. Blathy and an interesting letter of the same gentleman might have to do with this controversy; we are only surprised that Messrs. Gaulard and Gibbs have not published that letter at an early period; perhaps this would have rendered unnecessary the whole controversy which, we fear, may have become already rather tiresome for the readers of this journal. As the matter stands, we must have patience in awaiting the moment Messrs. Gaulard and Gibbs will judge proper for the publication of private letters, and we presume that Mr. Blathy will not fail to give the explanations which might eventually be necessary.

We herewith declare that as the method of Messrs. Gaulard and Gibbs in treating public disputes has rendered sterile the present controversy, and as we are convinced that those of your readers for whom the matter in question might have some interest, no doubt have already constituted for themselves an opinion as to the state of things—we have neither cause nor desire to pursue this controversy.

We thank you for having kindly permitted us to publish our letters in your esteemed journal.

Charles Zipernowski,
Max. Deri,
O. T. Blathy.

Budapest, *December 27th*, 1885.

Domestic Electric Lighting.

In accordance with a promise made to you at the time you inserted in your valuable journal some particulars of my installation at Sydenham, I beg to forward figures showing the working cost for the six months ending December 31st, 1885.

The installation now consists of 2—95 v. 10 C.P., 35—47 v. 10 C.P., 275—95 v. 20 C.P., 6—42 v. 30 C.P., 5—95 v. 50 C.P., 2—95 v. 100 C.P., Woodhouse & Rawson lamps, in all 325 lamps. This number is distributed over three houses.

The current is delivered to the lamps by an E.P.S. battery, consisting of 50 three horse-power cells of the ordinary L type plates; these are charged by a number five Phœnix dynamo, driven by an 8 horse-power Otto gas engine.

The installation has cost, without fittings, £1,500. The cost of working it during the above-mentioned period has amounted to £92 1s., made up as follows:—

	£	s.	d.
Gas	60	6	0
Oil and cotton waste	2	9	0
Trueing commutator	1	7	0
2 pairs brushes	0	14	0
Renewals, 31 lamps	7	15	0
Wages	19	10	0
	£92	1	0

The discharge of current naturally varies very considerably during the evening; but, except on special occasions, does not exceed 60 ampères. In the month of July I temporarily added 100 20-C.P., 8 50-C.P., and 4 100-C.P. lamps for the use of the stage in Westwood House. On the evenings when these were used the discharge went up to 90 ampères, the house lighting being reduced as much as possible during the time these extra lamps were lighted. I have got on fairly well with the accumulators; the chief trouble has been brought about by rather frequent short circuits. The cells, in one or two mechanical details, require material improvement. The India rubber plugs used for separating the plates do not answer at all well; some harder material is necessary for this purpose, as should any undue pressure arise, which is frequently the case, from a section getting slightly out of the upright, for instance, the soft rubber is squeezed out of its place, the plates come into contact, and mischief is the consequence. I have also found it necessary to add washers to the bolts and nuts used for coupling the cells, as in screwing the nuts up tightly in order to obtain perfect contact, which is of the highest importance, I found the brass nuts were inclined to cut into the lead of which the lugs are made. The scaling off of the paste from the plates is also likely, I believe, to be a cause of trouble. After a very short time a heavy deposit of this scale is formed in the bottom of the cell, bringing about a passage for the current and possibly, in bad cases, an absolute short circuit. The question of efficiency in secondary batteries has, apparently, not been made the subject of sufficient enquiry. It is, I understand, said to be 90 per cent. I have no opportunity of testing the question, but I can only say that I have to run the engine from 9 to 3 during the day and from 4 to 10 in the evening. Our charging current would average 50 ampères. This should give 600 ampère hours. The discharge during the evening certainly does not exceed 300 ampère hours, yet for this result it is quite necessary to charge as above stated. This shows a loss of just 50 per cent. I should add that the engine does not run on Sundays; the discharge is then somewhat lower. I was advised to run the engine in the evening during the heaviest part of the discharge by the makers of the battery, on grounds of economy, being assured that I should effect a saving in gas to the extent of 50 per cent. As to the time these cells are going to last, it is impossible to say with any certainty; mine appear to be still in fair order, although the efficiency appears to be lower than when they were first put in. They have now been in use exactly 12 months. I was assured by a gentleman well known in the electrical world, that after six months use they would be useless; this statement has, fortunately for me, proved incorrect.

I have written at some length on this question because I feel it is chiefly by the interchange of experience of users of accumulators that we may learn to overcome the many difficulties surrounding them. The question is a vital one to all interested in the progress of electric lighting. No installation is complete without a battery; no successful domestic installation is possible without one.

The machine I have been well satisfied with; it is well and strongly made. Its efficiency might, however, be rather higher. It gives above eight available E.H.P. for the 12 break-horse-power supplied to it.

The lamp renewals are higher than they should be. Eight lamps have been smashed by servants and others; the remainder have broken down by disintegration of the filaments.

The amount charged for wages is paid to a lad of seventeen, who has had entire charge of the installation for the last nine months. He knew nothing of electric lighting when he came to me; in a few days he had learnt all that was necessary for him to know.

This communication has assumed greater proportions than I had anticipated; my excuse must be that the subject is an important and interesting one, and should therefore be acceptable to your readers.

Aug. J. Littleton.

Sydenham, S.E., *January 5th* 1886.

I read with much pleasure the account in last week's issue of the installation for domestic lighting. Perhaps my experience of a still smaller plant may interest your readers. In August, 1884, I decided to light my house by electricity, and for this purpose I put in one of Crossley's ½ H.P. gas engines and a small dynamo. I live in a terrace, hence I was at first rather anxious if the working of the machinery would annoy my neighbours; but as the engine and dynamo were placed in an outhouse in the yard, the size of the room only being 8 feet long by 5½ feet wide, the noise was not troublesome. At first the exhaust from the engine was rather objectionable, but I entirely overcame this by putting a bend on the pipe to discharge downwards, and tying a piece of a sack round and round the pipe, not to prevent the discharge entirely, but to allow it to percolate through the folds of the bag. This entirely overcame the noise. The total number of lights in my house is 18. Of these, 14 are of 41 volts (16 C.P.), and 4 are of 82 volts. The dynamo is 50 volts. It is obvious that the 4 lamps of 82 volts get a very small amount of current, and give but a very faint light. This is intentional, as they are only used as night lights in the bedrooms, and where a faint light is desirable. Parallel with these 82 volt lamps are others of 41 volts, each being actuated by a switch, consequently when a brilliant light is required in the bed room, the lower resistance lamp is switched on; the "dim" lamp has another advantage, namely, indicating where the switch for the bright one is situated. I have often been perplexed, in hotels where the electric light is employed, to find the switch in the bedroom when all was in darkness.

My gas engine gives off (by actual brake tests) 1·2 H.P., and the gas used for this power is 42 feet per hour, *including the igniting lights*. The price of gas per 1,000 feet in Belfast varies somewhat in inverse proportion to the quantity used, but it may be taken at 3s. The maximum number of lights I can run direct from the engine is 8 of the 41 volts and 3 of the 82 volt lamps, equalling about 9½ brilliant lamps altogether; but as it is more economical where the power is limited to over-run the lamps for a given quantity of light, I get fully 20 C.P. from each 41 volt lamp. When first I started these lights I used a species of Planté battery, which I had picked up at an auction in Scotland; but it was useless either for storage or steadying the lights; but, indeed, by using a slack belt and a balanced fly-wheel in the dynamo, there was very little, if any fluctuation, in the lamps. However, I have now 24 cells of the E.P.S. Company, of the 11 S type, and, judging by my experience of them, they are everything I could wish for. The lights are absolutely steady, and under ordinary circumstances they are receiving a charge while some of the lights are used in the house. To accomplish this, I increased the E.M.F. of the machine to 56 volts (by running it faster). I then interposed some grades of resistance on the main leads between the lamps and the dynamo and battery; when the battery alone is employed, the additional resistance is cut out.

With reference to the relative *cost* of the electric light and gas for illuminating a house similar to mine, I find that if the interest on first cost is not reckoned, and if the attendance (in my case it costs nothing) is not added, the cost of the electric light is practically the same as a similar illumination by gas, but the advantages of the former are so immensely greater in other respects, that there is no comparison in the results.

J. H. Greenhill.

Belfast, *January 4th*, 1886.

The Brockie-Pell Arc Lamp.

My attention has just been drawn to a paragraph in your journal of 25th ult., criticising the test of the Brockie-Pell lamp as to its constancy of potential. It has been my experience of arc lamps, during the last six years, that a variation of only 3·3 per cent. is rarely met with, and I consider it a remarkable performance of an arc lamp to keep its potential so steady during a long run. I am sorry, however, that a grave clerical error had crept into the report of the test, as the variation was really only *two* divisions in 300, and not ten, as stated, but I still maintain that, even although the variation had been 3·3 per cent., your criticism upon this performance was hardly warranted.

I shall be glad if you will give this letter prominence in your next issue.

James Brockie.

14, Union Court, E.C.,
January 6th, 1886.

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